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OCTOBER, 1938

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WHY *Link-Grate Action* keeps boiler capacity UP and costs DOWN

The whole surface of the Link-Grate is air-admitting, which enables it to support the high combustion rates encountered in operating boilers at high ratings.

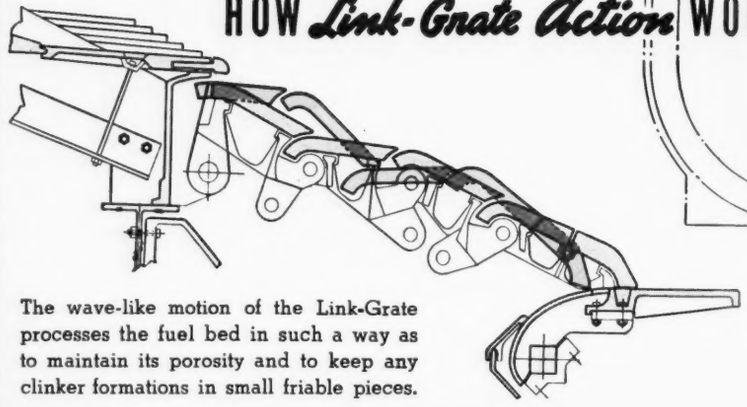
The motion of the Link-Grate maintains the fuel bed in a porous condition, insuring the thorough mixture of the air with the fuel. At the same time, the clinker formation is limited to small size pieces so that the air readily passes through the grates and cools them.

Best evidence that Link-Grate Stokers keep boiler capacity up and costs down is attested by the results of its many installations. For example, a plant in the South increased steaming capacity 31 per cent and lowered its steam costs 10 per cent by using Link-Grate Stokers.

• • •

Qualified Combustion Engineers located in principal Westinghouse district offices will be pleased to give you full information. J-50174

HOW *Link-Grate Action* WORKS



The wave-like motion of the Link-Grate processes the fuel bed in such a way as to maintain its porosity and to keep any clinker formations in small friable pieces.

DEPENDABILITY
FLEXIBILITY
HIGH EFFICIENCY
SAFETY
LOW MAINTENANCE

Westinghouse Stokers

Essential Factors in Low-Cost Steam Generation

1 *because* . . The fuel bed is kept uniformly porous.

2 *because* . . The wave-like motion prevents formation of large clinkers.

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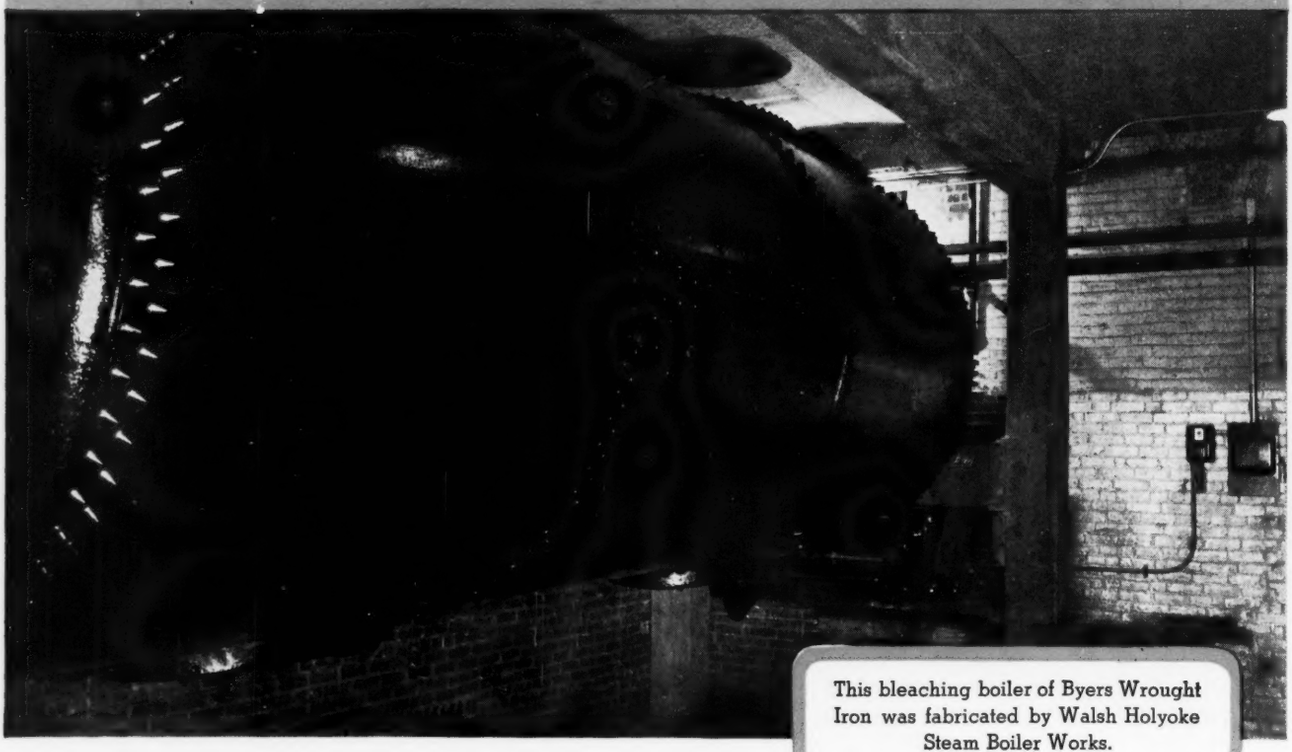
Combats Quality-threatening Corrosion for L. L. Brown Paper Co.



This bleaching boiler of Byers Wrought Iron was fabricated by Walsh Holyoke Steam Boiler Works.

When processing operations are affected by corrosion, proper selection of materials becomes of supreme importance.

The L. L. Brown Paper Company, Adams, Mass., for instance, found that corrosion in the bleaching boiler was a threat to paper color, and to a reputation for quality this company has enjoyed for eighty-nine years. The company studied, compared—and specified Wrought Iron as the best solution to its problem. This company also uses Wrought Iron almost exclusively for steam services of all kinds and condensate lines, and galvanized wrought iron in cold water lines.

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Public Relations for Industry

With Special Reference to the Power Field

A Presentation of the Imperative Need of Mutual Understanding in the Conduct of Our Daily Work

Presented by POWER

A McGRAW-HILL PUBLICATION

An Editorial Service to Meet

Industry's Major Problem

To the readers of POWER:

THERE IS NO DOUBT that today the American people are taking a keener, more critical interest in the conduct of business than ever before. And when I say critical, I mean exactly that. During recent years most of them have suffered loss, either of jobs or of savings, and under such circumstances men are prone to accept without serious question any scapegoat that appears plausible. In the confusion of fears and resentments, they seem to have concluded that short sighted and selfish business management is chiefly responsible for their misfortune.

However mistaken and unfair such conclusions may be, management cannot ignore them. It must recognize that in the long run, the opinions of men are the result of experience, of what happens to them each day, much more than of what they are told.

Progressive management has already faced that fact; has already begun to think and work beyond the technicalities of production and distribution that once absorbed most of its energies. It sees more clearly and deals more proficiently with its human responsibilities. It is learning to reconcile the economic success of the industrial unit with the social welfare of worker and community.

Presently, every business—the small retailer as well as the large manufacturer—must learn how to interpret more convincingly to its own public the social as well as the economic benefits of its policies and accomplishments. Only as each business satisfies the newly aroused and critical interest of people in its affairs will it be able to disarm those who trade on the human tendency to blame our troubles on someone else. Yes, if business as a whole is to win a favorable public opinion, each and every business must act to improve its own public relations.

The readers of this journal, and of other business publications, compose, we believe, a group that can achieve for American business a sound and lasting solution of this vital problem. They alone are in position to shape the working conditions of 21 million employees. In distributing and commercial organizations, they alone can mould the attitude of those other millions who compose the various "publics" to which all business must be responsible.

HERETOFORE, the function of business papers has been to exchange successful experience; to dig up and disseminate practical facts for the use of their readers, serving primarily the technical and merchandising needs of business. But this matter of human relations has now become of equal importance, for good industrial and public relations, it has been found, reduces corporate losses, removes fear and suspicion, promotes operating efficiencies in both production and sales. A better knowledge of public relations technique is, therefore, quite properly essential for men in, or moving into, positions of greater executive responsibility.

So, beginning with this insert, each McGraw-Hill publication sets out to strengthen its editorial service in the important domain of Public Relations. I hope that the million readers of McGraw-Hill's business papers will get much real and practical help toward building better relationships between their own businesses and their employees, their customers, and the communities in which they must carry on.

James H. McGraw Jr.

President, McGraw-Hill Publishing Co., Inc.

Why A Public-Relations Program

American industry, once so highly praised for its contributions to national well-being, is on the spot. The answer is a properly conceived and intelligently executed public-relations program to banish prevailing misconceptions

IN LESS than two generations the United States has changed from an agricultural to an industrial nation. Living standards and efficiencies at once the despair and envy of other countries have been created. Foreign delegations still flock to our shores to study our methods so that they may use them as patterns for their own organizations. Yet here at home today these methods and the systems responsible for them are under increasing attack.

Since every person employed in productive enterprise is a part of American industry, these attacks imperil the livelihood of nearly forty million workers and their dependents. The newest addition to the payroll has as much—if not more—at stake as the veteran business executive. That also is true of particu'ar industries which at present may not be under direct fire. All industry is so interrelated and interdependent that even the seemingly immune enterprise must suffer when the legitimate activities and the buying power of their customers, or the customers of their customers, are curtailed.

IRONICALLY enough, public acquiescence in many of the current attacks is an indirect recognition of the satisfactory manner in which our industrial system normally functions. Reasonable opportunities for the employment of those ambitious to put their mental or physical talents to work, and continually rising standards of living have come to be widely accepted as a matter of course. Any unfavorable change in these conditions leaves the general public surprised, confused and resentful. Such reactions as these make it easy for pressure groups to unloose destructive propaganda which further heightens resentments and breeds new misconceptions.

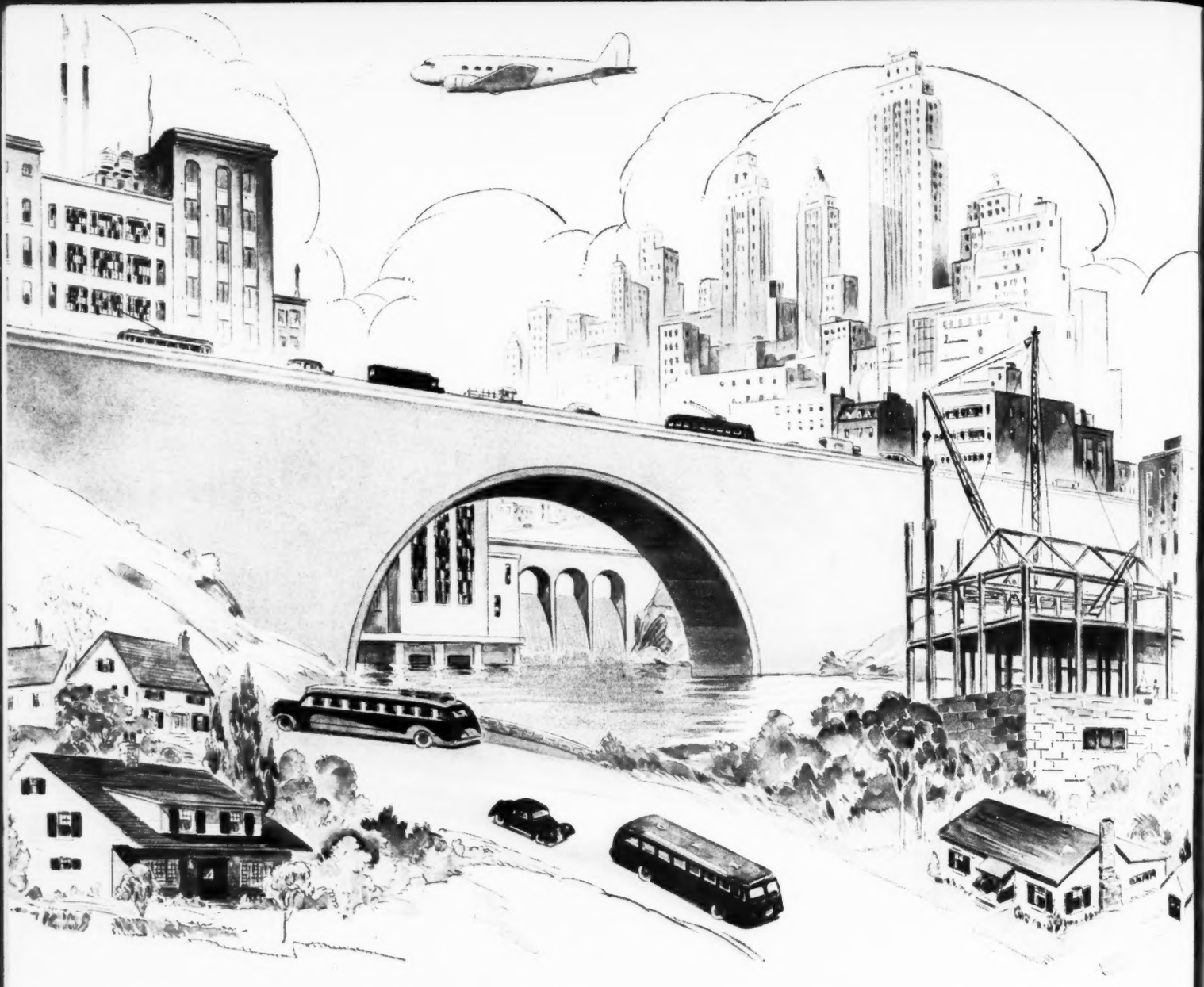
These misconceptions take many forms shaped by the experience, the inexperience, or the special interests of the critics. To one it appears that business can't manage itself and must be owned and managed by the Government. Another believes than employees are underpaid or that stockholders and executives are overpaid. To others corporate surpluses are too high. Many have convinced themselves that power and machines have reduced employment opportunities; and that industry can raise wages and reduce prices while costs go up.

Several misconceptions are based on faulty generalizations. Because a few companies have been remarkably successful, it is argued that all could make money. Because some corporations have been ruthless, all corporations, it is contended, will stoop to unethical conduct to gain their ends. This is like saying: John Smith killed Bill Brown; John Smith is auburn-thatched; all redheads, therefore, are murderers. Unfortunately, those who would indict all business for the crimes of a few are more subtle in their approach and so create an impression not in accord with the facts.

To put it bluntly, American industry, once so highly praised for its contributions to the national well-being, is now on the spot. Prevailing misconceptions of how business operates and what it does have made a field day for those who propose to hamstring or destroy private initiative and individual opportunity. These proposals run a broad gamut: They include pub'ic ownership, increasing and rigid federal control at the expense of local autonomy, ill-conceived legislation on hours and wages, labor dictatorships, and confiscatory taxes on thrift and employment security.

While the man in the street may be criticized for his willingness to swallow these nostrums, he is not wholly to blame. Industry, too, has been at fault, in assuming either that he was fully informed on those phases of its operations which are properly a matter of public interest, or that a healthy curiosity should be discouraged. Misconceptions multiply where the facts are hidden.

The tragedy of the situation lies in the fact that it might easily have been avoided. In the simple days of local and localized industry, everybody connected with a particular enterprise knew everybody else connected with it, and the details of its operations were an open book. The boss and the employees were neighbors; the customers, for the most part, fellow towns-



men. Outside purchases were limited largely to those products which the local community neither manufactured nor raised. Competition in the modern sense was practically non-existent.

As industry developed and enlarged its field of operations, much of this early intimate personal touch was lost. The small enterprise grew bigger. In some cases combinations took in the local business and financial control passed out of the community. The local industry which still retained its identity was busy meeting increased competition and seeking to expand its distribution. Little attention was paid to changing conditions that were fostering misconceptions about the personal relations of the business. Bit by bit the close acquaintance and familiarity of the early days disappeared.

Common understanding of these things also was impeded by the greater variety of occupations as industry expanded. Each man's job became so highly specialized that the old feeling of common partnership in a joint undertaking frequently was buried in an exaggerated feeling of the relative importance of his own work. This made it easy for each occupational group to get the idea that its contribution to the undertaking alone was essential and that many of the other groups were parasitic or, at best, quite unimportant.

SUCH MISTAKEN beliefs are the exclusive property of no particular group. "Goods are valueless until sold," chants the sales staff; "without us the wheels of industry would cease to turn." The wheels would turn much faster, growls the production department, "if we didn't have so many lame-brains drawing fat salaries as salesmen." Under the cold glance of both groups, the clerical force heatedly inquires: "How long do you think this business would last if we didn't keep the cost records, send out bills and collect the money for pay checks?" Some executives and engineers, too, have been known to forget that their plans cannot be carried out without the cooperation of other groups.

Possibly the greatest single cause of misunderstanding and friction has been fuzzy thinking on social responsibilities. Many of the responsibilities which rested on the individual or the state in our fathers' and grandfathers' days have been shifted to the shoulders of industry. New ones constantly are added or proposed—often before industry has had time to adjust itself to those which have gone before. Some of these responsibilities affect employee relations; others involve customer relations. The worker, for example, no longer is completely defenseless against the occupational hazards of his employment. "Let the buyer beware" no longer is considered smart merchandising. Many of the changes now embodied in the laws were anticipated by

industry itself. Opposition—valid or otherwise—to social legislation, however, has been used to damn business in the public eye.

FORTUNATELY, the barriers to good will and common understanding can be broken down. The process is a simple one. It consists chiefly in maintaining good policies in human relationships and in keeping all interested people—employees, stockholders and their neighbors, customers and the general public—informed. It means telling them in plain terms what revenue is received and where it comes from, what revenue is paid out and who gets it, how an industry serves the individual, the community and other industries. Finally, it includes the acceptance of the social responsibilities which the advance of civilization imposes upon business.

Add all these things together and you have public relations.

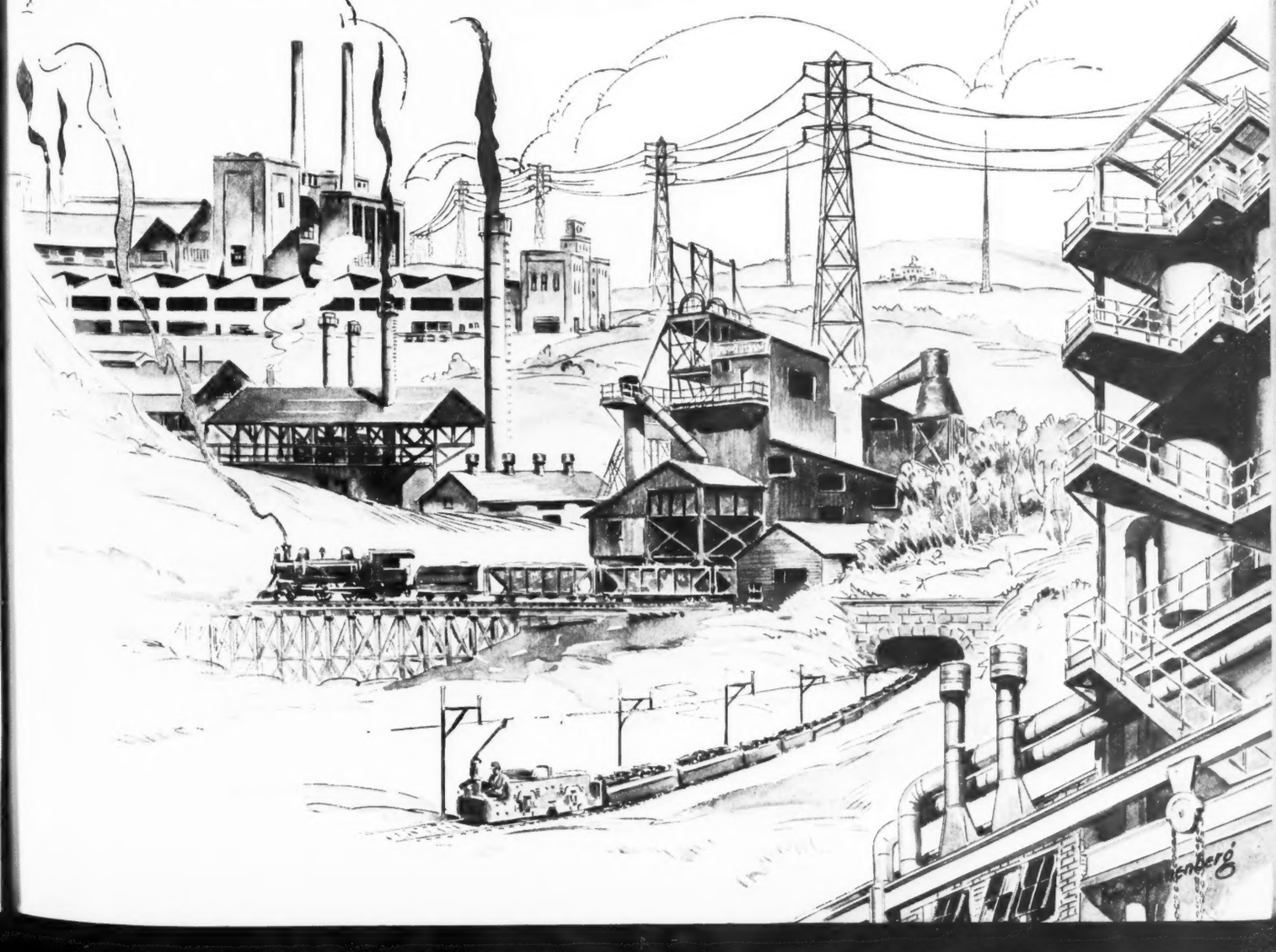
Most employers are willing to accept their social responsibilities, but they are inexpert in making that acceptance articulate. Too many employers have failed to make clear their policies, their practices and their purposes as they relate to fair dealing with employees, investors and the general public. Their intentions have been good, but they have cloaked them with a veil of secrecy and made a mystery out of simplicity. As a result the uninformed have been given a royal opportunity to exercise their imagination. And they have done it!

Public re'ations is a comparatively new activity for most business enterprises and involves a technique which too many have not yet learned. Obviously, the first place for each company to start is within its own organization. This is the "inside job" that builds a company's good name among its own family and lays the firm foundation for building public confidence and favor. As one exponent of the art phrases it: "Industry's public relations cannot be one thing and its private actions and policies something else. The two must be in complete accord."

The inside job should present no real difficulties to fair-minded employers. Most workers have a normal predisposition to view in a favorable light the organization in which they earn their livelihood. Most companies endeavor to conduct their operations so as to justify that favorable attitude. But too few of them are adept at dramatizing the facts that furnish a substantial basis for maintaining employee good will. So, where misunderstanding and suspicion born of ignorance exist, time may be required to break down the barriers that have grown up.

THE TASK of telling this inside job to the outside world, however, will not be easy, for two reasons. First, it has been so long neg'ected that the backlog of misunderstanding is large. Second, public relations involves attitudes as well as actions, a viewpoint as well as an organization. Pubic re'ations is not a commodity that can be purchased like a car of coal or a bolt of silk; neither can it be sold by "canned" material. Each program to establish sound public relations must be individualized and indisputably stamped with the personality of the company promoting it. *And the deed must always back the word!*

But the task is worth the effort. For, with the inside job right, a properly conceived and intelligently executed public-relations program offers business the means of successfully counteracting unjust public suspicion, unfair political attack and unwarranted outside dictation. The need is urgent.



Essentials of a Public-Relations

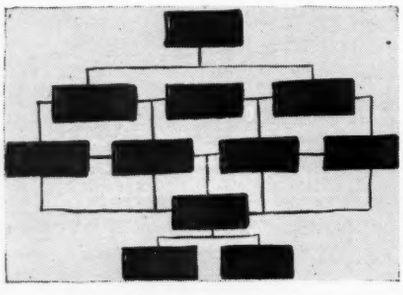
Inside

★

"A contented and effective organization and a good name." That, in one sentence, is the sole purpose of a public-relations program. It involves work within the company and without. Here are practical suggestions for the inside job

Set up a Leader

This work needs the leadership of an able executive, one who knows the business and is skilled in guiding human relations. This man should report to the chief executive.



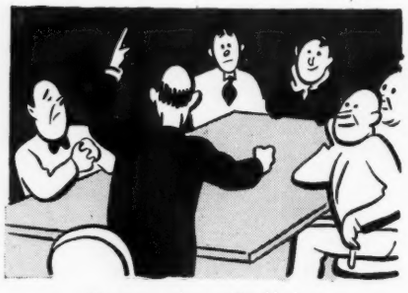
Clarify Organization

Uncertainty means an uneasy personnel, inclined toward political maneuvering. The organization of the company should be clearly defined, so that the authority and responsibility of individuals may be known to all. In most cases, this calls for more than a simple organization chart. A manual may be necessary. Whatever is done should make specific the line of authority and the functions of all officials.

★

A statement of personnel policies should be formulated by the top executives, aided by representatives of all the management groups. If satisfactory employee relations have been established, the statement should be submitted to the employee representatives. Once adopted, the policies should be made known to all employees.

Policy statements should be definite



Determine Policies

in such matters as wages, working hours, overtime, promotions, lay-offs, vacations, sickness relief, safety, training and education, profit-sharing, collective bargaining.

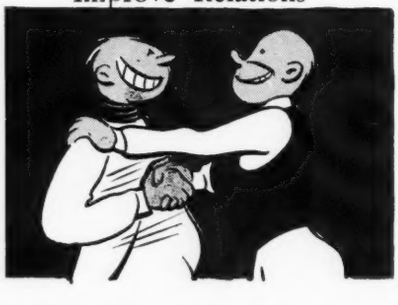
★

As far as the local situation permits, establish certain basic policies relating to:

(1) Payment of prevailing wage and salary scales;

(2) Evaluation of jobs, and setting up of uniform scales of pay for equal grades of work throughout the company;

Improve Relations



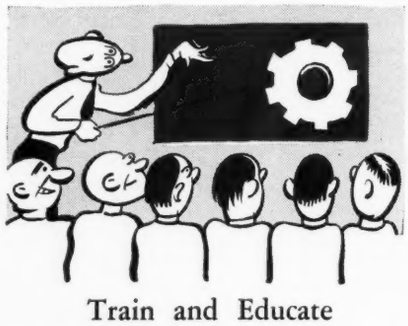
(3) Establishment of pay differentials, having due regard for working conditions, responsibilities, requirements in skill, mentality and physical application;

(4) Establishment of financial incentives, also, where possible;

(5) Setting up of positive procedures by which all changes in rates of pay are fully explained to the employees concerned.

Assure Well-Being

Make certain that working conditions are safe and sanitary. Provide adequate ventilation, heating, cooking, lighting. Eliminate unnecessary noise. Make suitable provision for rest, mealtimes and recreation. As far as possible, stabilize employment, organize protection against unemployment, sickness, old age and death. Where funds are lacking to accomplish all these things, set them up as ultimate goals.



Train and Educate

A suitable program should be developed for advancing men and women in the organization and as citizens of the community.

Having thus made working conditions as nearly ideal as possible, make certain that employees know what is being done for their benefit.

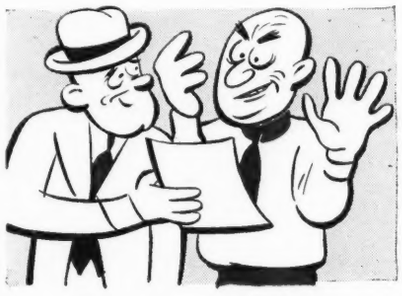
Program

Outside

★

Having done a good job on industrial relations within the organization, the most important step has already been taken toward building up good will outside. Following are suggestions for a definite program of outside relations

Manufacturers of equipment and producers of material that touch the lives of people only indirectly can show how their products raise the general standard of living. Companies that sell their products and services directly to people can interpret the resulting



Educate the Public

social and economic benefits in human terms. Both types of organization can publicize interesting facts about themselves, their policies and their products. Through trade and industrial associations, local and national, all types of business can join in promotional programs to inform and educate the public.

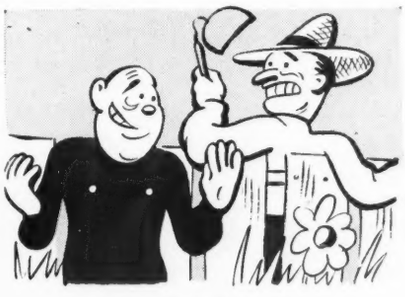
Inform Community

People in a community judge the local company by the things they are told, right or wrong. In promoting company good will, informed employees are assets of the company that has done the "inside job". A company can build good will by publicizing facts about itself, making them available promptly, accurately, clearly and frankly.

★

Yet merely telling the inside facts is not enough. The company must make itself known and liked by becoming itself a good citizen and neighbor. It must play an active and helpful part in community affairs. The community-minded company takes part in exhibits of the products of local industries. It cooperates closely with the local press, following a policy of giving the whole truth and nothing but the truth. It holds open house in the plant occasionally for visitation by the people of the community. It encourages employees to participate in civic affairs.

It may participate in operating a community foreman's club. It may circulate factory house organs to interested people outside the organization. It presents facts before civic organizations, women's clubs, luncheon clubs. It may show plant operations by motion pictures in schools and before other groups. It cooperates with local charities and charitable agencies.



Be Neighborly

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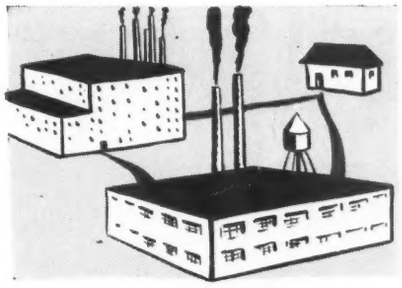
Within its own industry, the company should exchange public-relations plans and experiences, working through its trade association as a clearing house. A part of this clearing-house job can be the collection of statistics about industry, and their presentation to member companies.



Cooperate

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By helping the local community promote itself outside, the company may build good will. The various local companies working together can present to the world at large, facts—straightforward industrial facts—about the community.

Promote the Community

At the same time, through the local press, it can show that the welfare of the community as a whole, and of all the individuals who live there, is bound up with the welfare of the local industries.

In Conclusion

Both the inside and outside job shou'd be part of one general plan, managed by an expert with public-relations experience. This is essential to success. Another essential is that the entire program have the solid backing of the company executives.

Teamwork in the Power

"First put your own house in order" is the golden rule of sound public relations. Here are practical suggestions for good human relations within the sphere of the power engineer

THE POWER ENGINEER holds a unique position in today's industrial civilization. He alone is in close contact with the ultimate worker, on the one hand, and with top management on the other. He alone generates the power services that are the life's blood of every department of every establishment in every industry. He is the only man living with an adequate and simultaneous understanding of men, machines and power.

This unique position brings its parallel responsibilities. Of all men, the power engineer can best interpret management to wage earners and *vice versa*. He personally should make clear to all the relation of power and machines to the true interests of men, for no one else understands it so well. Finally, his is the unique opportunity to establish in every unit of every American industry, and in every major building and institution, sound human relations in its most basic and pervasive department.

Janus

Like Janus, the engineer looks always both ways. He is not "capital" and he is not "labor". He is merely a highly intelligent "doer", endowed with responsibility to get the power job accomplished by any means at hand, whether it be a corporation balance sheet or a first hand understanding of chimney construction. In general, he has a practical background in several trades. From personal experience he knows how the mechanic works and thinks; yet he has equal facility with budgets, investment studies and the other tools of management. Who in all industry is as well fitted to bridge the present gap between wage earner and top executive?

Defender of Men and Machines

Powered production machines are man's best friend, but many fail to understand this, because they understand neither the machines themselves nor their economic function. Too bad for all concerned! And who, other than the engineer who makes the machine, can reveal its inner meaning.

Result Getter

In the future the engineer must become more vocal, but then, as now, his main contribution will be silent and effective action. His basic public-relations job is to keep "juice" on the line at all times. If his power fails, nothing else, human or otherwise, can be right.

His next job is to deliver high-quality power services in ample quantity and at low cost to speed production, fill pay envelopes, and lower the prices of the goods these pay envelopes buy.

Man Builder

For his own sake—as well as for the sake of labor, management, owners and consumers—the engineer must be a builder of men within his power department. This means he must provide bread and butter *plus* something else. For if men cannot live by bread alone, neither can they live without it.

On the one hand, any talk of harmonious human relations is mere clap trap without fair wages and hours, security, safety, sanitation and the opportunity to advance on merit.

On the other, discontent often exists in the very face of basically fair working conditions. What's the answer? Human relations. Angels may fear to tread this field, but the power executive must live and act in it, burdened though he be with an overwhelming variety of responsibilities. He is already a power technician, an accountant, a master of several trades, a manager, an investment analyst, a buyer. On top of all these, he must master this problem of "people", his toughest job of all.

They talk of the "science of human relations", but it's still mainly an art. No logic, or body of rules, will cover the subject. To a large extent human relations must be regulated by instinct and intuition. But not entirely; there are *some* safe rules for dealing with men. The first step is to divide human reactions into two classes: those common to all men and those in which every case is special. For the first group one may have rules, for the other not.

All Men Are Alike

With few exceptions all men are alike in the following traits:

They all like good pay, comfort, a clean place to work, the chance to move ahead, security.

They all like personal prestige.

They all like to be doing something important.

They all prefer to receive orders that seem to make sense.

They all prefer to work for a man they respect.

They all hold in greater respect the man who could, if necessary, execute his own orders.

They all react favorably to square dealing, *if it is recognized as such.*

In America, at least, they all have an intense dislike for snobbery and condescension.

They all dislike the man who scorns them, *or seems to.*

They all dislike confused leadership.

These universal traits of human nature are well known. They are the basis of safe rules for dealing with people.

And All are Different

Yet, in as many other respects, men differ. Some like company; some don't. Some are silent, some talkative. Some have initiative; some have not—and so on. Here is a vast field where all rules fail—where each executive must work by intuition and by his own keen observation of how men react. Here the thing that counts is not his good intentions or even his honorable actions, but the impression he leaves.

Examples are easy to pick. Take the matter of "personal interest". The wife is sick and the boss asks how she is coming along. A bit of common decency, rarely resented! Go a

Department

step further and ask about home, garden, hobby or vacation activity. Generally well received, but you can't be sure. Who can say where friendly interest in personal affairs suddenly becomes an unwelcome intrusion? Every case is different. The only sure thing is that the wage earner has his right to his private life and that too little is better than too much in such matters.

Tell Why

One more illustration! When orders are given, how far should instruction and explanations be carried? Obviously too little may lead to errors and bad feeling. Too much may kill initiative and self respect. Each man has his particular field of skill. He expects it to be recognized. You don't tell a sailor how to tie a knot.

Tune In

No one could list all the ways in which human contacts may be fitted to the man. The point is that they *must be fitted.* The process is much like the tuning of a radio set. You turn the dial and listen. The pickup gets stronger and clearer. When it starts to fade, you stop turning. Mark Twain tells of the too-long missionary sermon that caused him to steal fifty cents from the collection plate. The preacher had tuned him in and out again.

Cards on the Table

From the very nature of his job, every power executive will already have given much thought to these matters. The foregoing comments will not come to him as news—merely as a reminder and a summary.

We come now, however, to a suggestion that will be new to many. Men experienced in public relations agree that the wide-spread feeling against those who own and manage industry thrives on lack of information. The power executive may greatly improve the morale of his department by giving his men straightforward facts about their company—its earnings, dividends, total salaries paid, total wages, and so on. While the opposite is generally true, most wage earners imagine that less money goes to them than to owners and management combined. Why conceal the true facts?

It may also help to make available similar facts on the distribution of money by industry in general and on the relation of power and machines to wages, buying power and employment. The material on the following pages is designed to help in this connection.

★★★

TO SUM UP

Power Man

Far more than the public imagines, the power man is also a "man of power" in the field of human relations.

★

Binder

In daily intimate contact with the men and problems of management on one side and of wage earners on the other, he is uniquely situated to interpret both ways.

★

"Juice On Line"

Yet his number-one public-relations job is still to keep juice on the line at all times—and his second to make it ample and cheap, as his contribution to prosperity.

★

Bread and Butter *Plus*

In *some* respects all men react alike. There the problem of human relations is simple. Merely learn and apply rules based on universal experience.

★

The Human Side

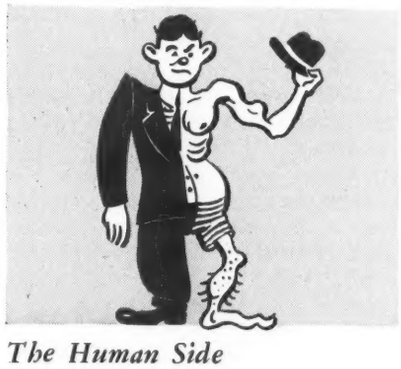
But for many human relations there are no rules. Each man is his own law. One man must "tune in" on another, and nobody else can tell him how to do it, beyond suggesting a steady hand and an attentive ear.

Power Man

Binder

"Juice on Line"

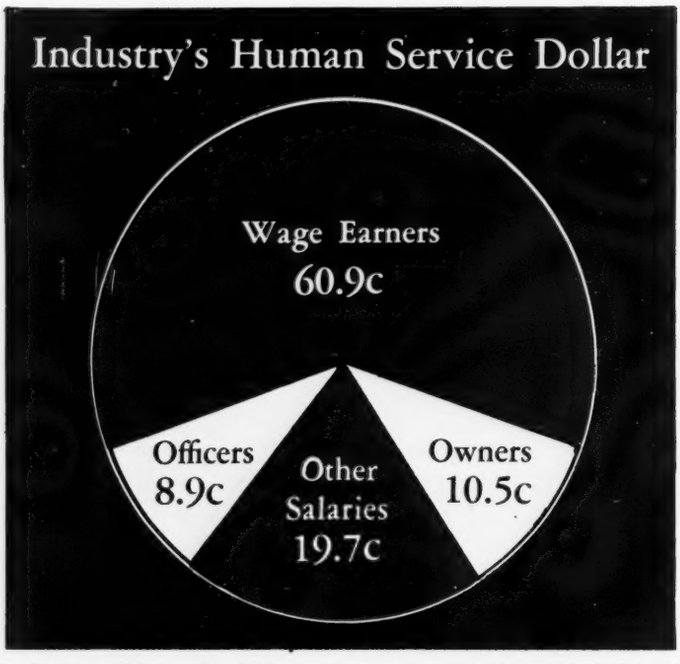
Bread and Butter PLUS



The Human Side

Man's POWER Partner

The simple story of men working for a living and of machines working with them to turn out more goods with less effort, thus giving all America more food and better clothes



Of each dollar paid out by industry in wages, salaries and dividends, wage earners get 60.9 cents. The *percentage* has changed little over the years, but the total *number* of dollars to be divided in this manner has increased almost in proportion to the use of power-driven machines to create wealth

TODAY, as always, Man carves out his own prosperity—

A—Eats only what he harvests
B—Wears only what he spins, weaves and sews
C—Lives only in man-built houses
D—Rides exclusively in man-made transportation.

THUS *average* individual prosperity, that is "living standard," is merely total national production divided by population. By national production we don't mean dollars (they're made in a mint and can't be eaten or worn). We mean real goods. Note that this is the whole story of *average* individual prosperity, regardless of prices, wages, hours of labor or anything else.

ADMITTEDLY certain individuals suffer from unbalanced distribution, even when the *average* living standard is high. Meanwhile let's agree on a few basic facts: Prosperity for the entire population is absolutely impossible without high national production. This is a matter of simple everyday arithmetic.

THEREFORE every man who desires prosperity for everybody must necessarily advocate high national production. And he must necessarily favor the widest possible use of the so-called "labor-saving" machinery, without which high production is impossible. And the widest possible application of power to machines, for the same reason.

BUT RIGHT here comes the hitch for many minds. They see a man with a regular pay check. They see, or think they see, a "labor-saving" machine put him out of a job and stop his pay check, so he isn't prosperous any more —not by a long shot.

SO SOME SAY, "let's use less labor-saving machinery to make more jobs." Sounds good? Then someone else says "let's throw away all the road machinery and use shovels. More jobs!" Some think this sounds logical.

THEN ANOTHER man says "Why not use teaspoons if you want to create employment by cutting down the amount a man can accomplish in a year?" It's just as logical as the shovel argument, but common sense begins to smell a rat and so rejects it. Jobs or no jobs, we shall all certainly starve to death if we follow this reasoning to its logical conclusion, and try to do all the world's work with teaspoons.

WELL, what is wrong with this reasoning anyway?" It's a fair question. In our opinion, the basic error is in thinking about jobs and not about production. If you have ample production the jobs will be there—and they will be *good* jobs.

IN THE BEGINNING men did not work for the sake of a job. They worked to produce clothes, food, housing, luxuries. The less effort it required to produce the goods they needed or wanted, the better they were satisfied. But today some think of factories as devices to give people work, and of people as devices to keep food factories busy.

THAT'S PUTTING the cart before the horse. The real purpose of factories is to produce necessities, comforts and luxuries for people to use and enjoy. The more efficiently they do that job, the better off will be the population which needs clothes, housing, comforts and luxuries. And the idea that doing this job effectively creates unemployment has no foundation.

DON'T WE BELIEVE, then, that the present serious unemployment in this country is caused by the widespread use of labor-saving machinery? We do not.

TAKE the automotive industry. Do you know of any that has been more active in promoting the use of efficient machinery? Time and time again new machines have enabled one man to do the work of two or more. Year after year, it takes fewer man hours of work to turn out a car, and year after year more men are building cars—also building roads, running refineries and service stations.

YOU KNOW the answer. Cars and roads got better. Car prices came down. The industry was able to pay higher wages. More people, with higher wages, bought better cars that cost less —and drove them more miles over better roads. As a result the automobile-manufacturing industry employed 387,000 wage earners in 1935 (latest official figures) and paid them $545,000,000 total wages.

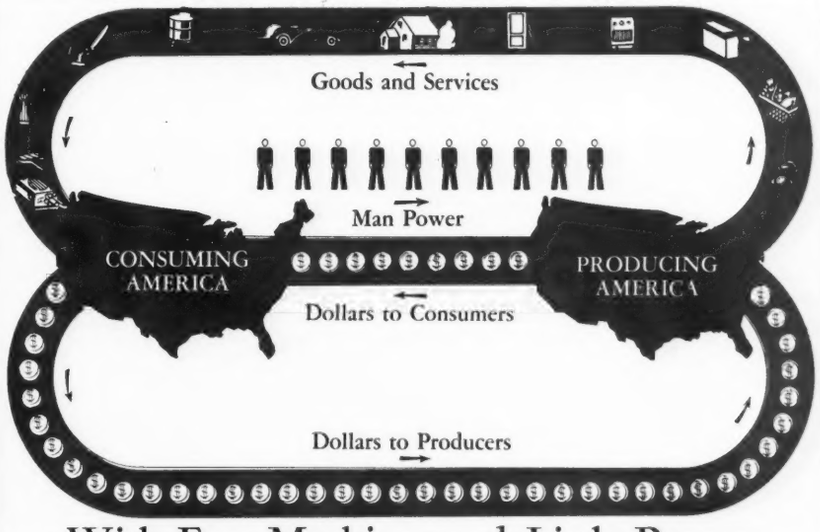
IF THIS IDEA that labor-saving machinery creates unemployment is a complete fallacy, why is it so widely held even by intelligent people?" The answer is in two parts: First, we happen to be living at the moment when extensive use of machines coincides with wide unemployment, just as the exact opposite has frequently occurred in the past. When two things happen at the same time people have a way of assuming that one is the cause of the other.

SECOND: When a new "labor-saving" installation is made, the labor "displaced" is all in one spot where you can count it. Moreover demand for the particular product may be less flexible than in the case of automobiles, so that employment in that particular plant or industry is actually reduced. In that case the savings (passed along as lower prices, higher wages and higher dividends) create an equal number of new jobs, but they are scattered all over the United States where you can't count them. Many people will not believe what they cannot see with their own eyes.

EVERY TIME a new labor-saving device begins to create manufacturing savings, these, in turn, create an equal number of jobs, either in the same plant or somewhere else. At the same time, the national production is increased, so there is a net gain in the standard of living of all the people.

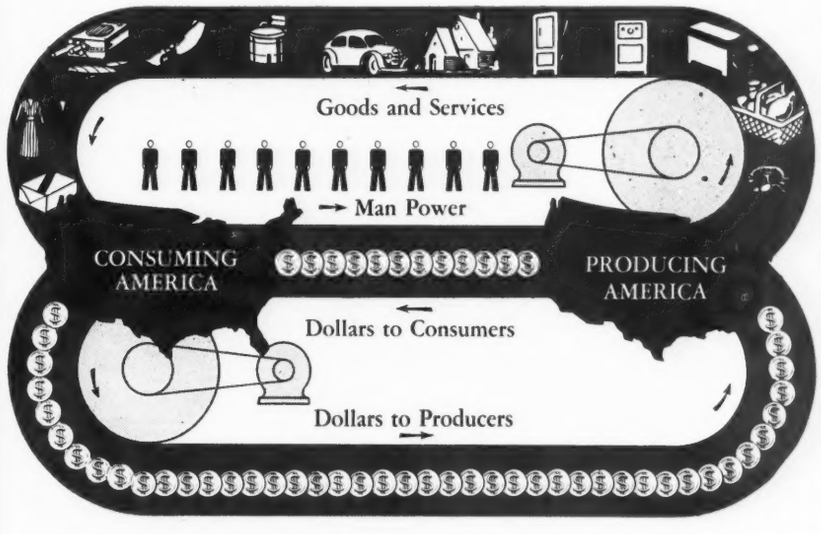
SO WE SAY that the widest possible use of machinery will cause no unemployment and will steadily raise the standard of living. Through higher wages or lower prices or both, the weekly wage of the average worker will buy more necessities and luxuries.

ANYONE who, with good intentions or otherwise, convinces the employee that low production will advance his interests is no true friend of the wage earner. Because we believe in the machine as man's friend, we must believe in its life blood—power—without which machines can do nothing.



With Few Machines and Little Power

Producing American Produces Little—Consuming America Enjoys Little



With Many Machines and Much Power

Producing America Produces Much—Consuming America Enjoys Much

Consuming America can never enjoy more than Producing America delivers. High production by producers simply means high prosperity for consumers.

Dollars flow from Consuming America to Producing America to pay for goods purchased. These same dollars flow immediately back to Consuming America as wages, salaries and dividends. In return Consuming America gives Producing America the man power without which it cannot operate.

Producing America and Consuming America are really the same thing. The employee who makes automobiles, for example, also consumes automobiles and other goods.

Thus, when Producing America delivers more goods in a year to Consuming America, it simply means that America as a whole is presenting itself with a higher standard of living —that Americans everywhere have better houses, more and better cars, more and better food.

Where man power is reinforced by many machines and by ample mechanical power, more goods flow. No fewer workers are needed, but they get more done. Resulting greater earnings and lower prices make it possible for them to buy the increased output.

More power and more machines simply mean that the earnings of the average citizen will buy him a better living.

Power + Machines = Prosperity

In America's Half-Century Trek from the...

Horse and Buggy Days of 1879	to	The Power and Machine Days of 1929 *(latest complete statistics available)*
49,093,000		POPULATION INCREASED 2½ TIMES 121,526,000
2,733,000		FACTORY WAGE EARNERS INCREASED 3¼ TIMES 8,822,000
3,411,000 Hp		FACTORY HORSEPOWER INCREASED 12½ TIMES 42,869,000 Hp
$5,370,000,000		TOTAL VALUE OF PRODUCTION INCREASED 13 TIMES $69,961,000,000
$948,000,000		TOTAL FACTORY WAGES INCREASED 12¼ TIMES $11,607,000,000

The net result, to factory wage earners, of this half-century's advance in the use of power-driven labor-saving machinery is:

1. Horsepower helping each wage earner increased about 4 times
2. So his individual production increased about 4 times
3. And his individual yearly wage increased about 4 times
4. Yet the number of factory jobs (wage earners) increased 1⅓ times faster than population

POWER

Established 1882 PHILIP W SWAIN, Editor

Plain Speaking

IT WAS A TYPICAL engineering-society meeting. In the hall sat two hundred average power engineers — mainly operators, with a sprinkling of manufacturers' representatives. The menu went from soup to nuts on diesel engines. Five different papers were presented by men selling five different makes. All papers were different, but in one respect all were alike. Every man's engine was "perfect." Nobody had any troubles. Fuel-oil and lube-oil consumption was always low. Pistons never seized. Crankshafts never broke. Maintenance was no problem.

It appeared that the whole problem of selecting and operating an engine was so simple that the office boy could pick an acceptable unit from any one of a dozen different makes and the janitor could run it.

That is, it looked that way until Mr X began to speak. Mr X was one of those pessimists you can't help liking. He, too, was a builder of engines, but his life had been nothing but a long string of troubles. Way back he made one engine he thought pretty good, but it wasn't; it threw its pistons! He fixed this up in the next model, but that one broke its shaft—no kind of a job for any sensible customer. The next engine actually ran, but it was a hog for oil—and so on for twenty-five minutes—just one trouble after another.

The meeting ended, but a big group clustered around Mr X. He was their kind of man. They, too, were the sort of birds who had troubles, who had not yet achieved perfection. They clamored eagerly for further advice from another man who had learned by experience—and was still learning.

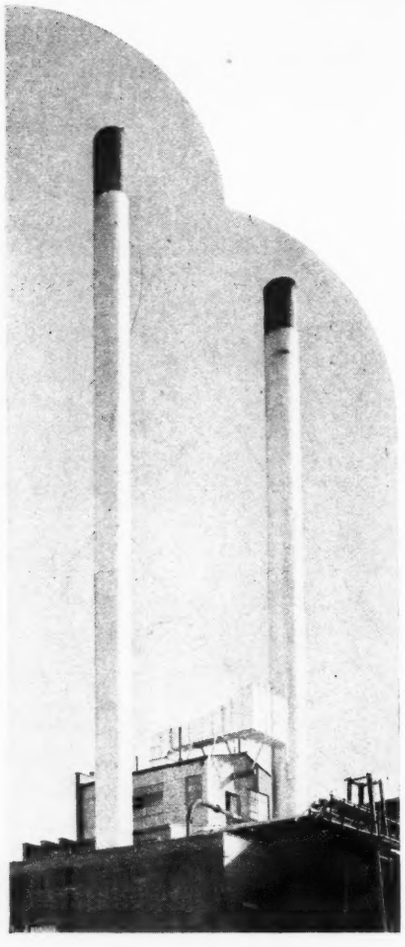
Strangest of all, they seemed to feel an added confidence in the engine made by the man who had produced so many "failures." They trusted him. They believed him when he told of the troubles he had. And they also believed him when he told of the cures.

The homely wisdom displayed by Mr X is as old as mankind. Yet some, strange to say, never learn it. Year after year, some salesmen go on talking "perfection" to men who have known no perfection in their whole lives, to men who instinctively distrust the claim of it. This sort of thing happens over and over again, with products ranging from boilers to condenser tubes. The actors change, but it's the same old show.

Much modern propaganda, even propaganda for worthy causes, is tarred with the same brush. Why do advocates of this cause or that go on year after year claiming perfection for the things they promote? No program is perfect. There is always a grain of truth in the doubts and questions of opponents. And why don't more of us, more often, see the necessity of earning the belief of the listener in our honesty, fair-mindedness and intelligence.

Inspection of much that is published indicates that it is written to please the man who hired the writer, not to win over the honest doubter. The facts, good enough in themselves, are made too pretty. Everything is lovely. Nothing wrong. The audience listens politely and goes out by the same door by which it entered. "A man convinced against his will is of the same opinion still."

In the years immediately ahead, America as a whole, and American business men as groups and as individuals, face a tremendous job of public education. In doing this job, it is utterly essential that they get away from this "perfection" stuff, get down to the everyday world of trial and error where the ordinary man lives.



It's Still Tops at Container Corp

Success of top in Manayunk plant sets pattern for modernization of Carthage, Ind. paperboard mill. 600-lb boiler and backpressure turbine expected to save $50,000 a year

By SAMUEL BLUM
Engineer, H M Wilson Co, Engineers and Constructors

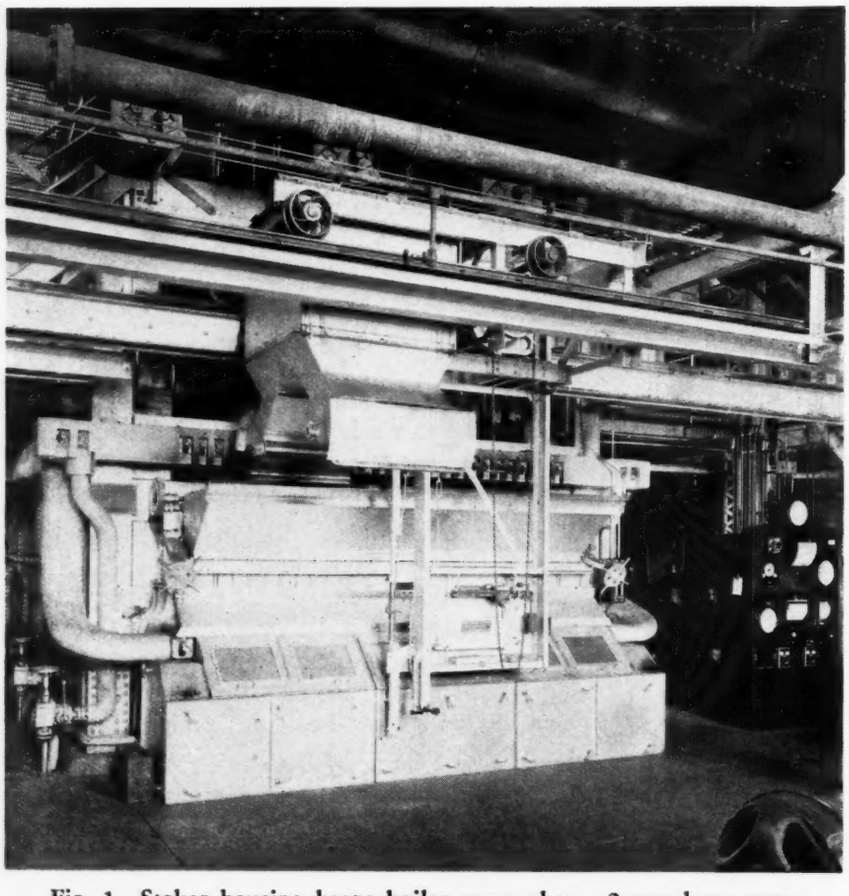


Fig. 1—Stoker housing keeps boiler room clean. 2-way larry serves new boiler and old units

SO SUCCESSFUL was the high-pressure venture of the Container Corp of America at their Manayunk, Philadelphia, plant (described in *Power,* August, 1936) that when consideration was given to modernization of power facilities at the Carthage, Ind. plant, there was no hesitancy about applying the "topping" idea again. Experience had shown that superposition fitted the power and process requirements of the paperboard industry, and that high-pressure, high-capacity equipment was entirely dependable.

Analysis revealed that a high-pressure installation at Carthage would reduce hourly steam requirements from 80,000 lb to approximately 60,000 lb, when the plant was producing its average of 120 tons of paperboard per day. Anticipated savings in annual operating costs, based on 1937 production, are estimated at slightly more than $50,000 after allowing for depreciation on the new investment, taxes, insurance, and other fixed charges. This represents a reduction of $1.64 in cost of steam and power per ton of product. Such savings would have warranted modernization even if continued dependable operation had been possible.

The Carthage plant was built 40 years ago, and changed hands several

times during that period; when the Container Corp took possession, power equipment was suffering from deferred maintenance. Existing boiler plant comprised two 5000-sq ft Heine boilers, and one Erie City unit about the same size. All three were fired by single-retort side-dump stokers and to produce the average steam requirements it was necessary to drive them at almost 200% rating, which could only be done by burning West Virginia coal instead of cheaper local fuel. A fourth boiler had been abandoned, and was removed to make way for the new high-pressure unit.

An engine-driven fan provided forced draft. Coal was delivered by car to a track hopper and conveyed to an overhead bunker from which it fed to individual stokers through spouts. The same conveyor carried ashes to cars or to ground storage.

Former Power Generation

Nearly all current was produced by a 1500-kw bleeder-condensing turbine operating at 160-lb throttle pressure, with 10-lb extraction. Engine drives on paper-mill machinery operated on 160-lb steam, also. Mill water flowed through the condenser as circulating water; the supply was adequate for all loads. Small quantities of energy were purchased and an old engine-generator set was available for emergencies.

Since existing boilers were capable of carrying average load, even though with difficulty, it seemed advisable to overhaul them to serve as standby, thus limiting immediate capital expenditure to one new unit capable of carrying the entire load. This was located near an existing steel stack into which the new induced-draft fan discharges. Plans call for a future unit of like size on the other side of the same stack, to the right of the boiler shown in Fig. 2.

Coal Handling

Rebuilding the coal bunker in its original position and providing a 2-way larry makes it possible to feed both new and old stokers. Existing conveyor, track hopper, crusher, and apron feeder were salvaged. Two motor-driven Sturtevant forced-draft fans, at firing-floor level, replace the old engine-driven unit, and serve both old and new boilers. Old 160-lb pumps were relocated alongside new 650-lb Pennsylvania units making room for an additional filter and new chemical mixing and feeding equipment. Space formerly occupied by an old rope-drive engine made an ideal location for the 1500-kw topping turbine, and pressure-reducing and desuperheating equipment was installed along an adjoining wall.

New Boiler Setup

The new boiler, built by Combustion Engineering Co, is a 4-drum bent-tube unit with a continuous rating of 80,000 lb per hr of 575-lb, 665-F steam and a sustained peak rating of 100,000 lb per hr. Its 9010 sq ft of heating surface accounts for 61% of the total, and the 4510 sq ft of the Elesco economizer adds another 30%. Remaining surface is divided between 846 sq ft of water wall and 420 sq ft of superheater.

General arrangement of boiler and auxiliaries is shown in Fig. 1. By use of bypass connection to the stack, the economizer can be taken out of service and the boiler operated at reduced rating. Roomy grating walkways are provided at numerous levels, connected by easy stairs, making all valves and doors easily accessible. Refractory tile, high-temperature insulation, and gas-tight casing plates back up waterwalls and boiler roof. All brick walls are backed with 85% magnesia block and steel casing.

Most available and advantageously priced fuel is Indiana bituminous se-

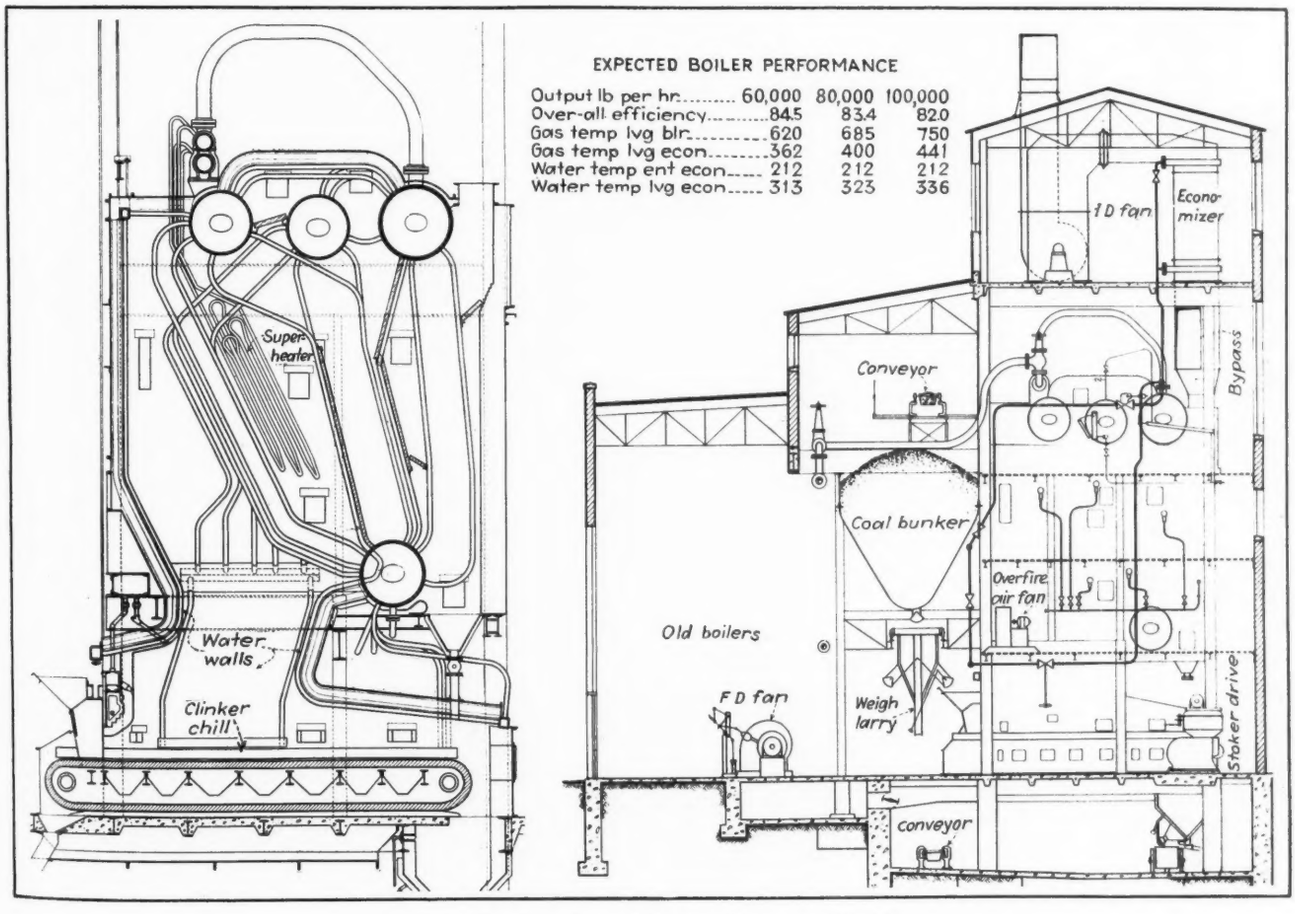


Fig. 2—Section through boiler house and boiler

TABLE I — FEEDWATER ANALYSES

	Raw	*Leaving Primary Tank*	*Entering Boiler*	*Boiler Blowdown*	*Sat. Steam*
Turbidity as SiO_2	V.S.Trace	None	None	V.S.Trace	None
Suspended matter	Present	None	None	Trace	None
Carbonate hardness	252	14			
Non-carbonate hardness	72	0			
Total hardness	324	14	0	0	0
Sulphates	80	68	76	928	0
Chlorides	3	2	1	32	0
Iron	Trace	None	None	None	None
Free carbon dioxide	11.0				10.0
Bicarbonates	252	0	6	0	4
Carbonates	0	72	36	224	0
Hydrates	0	0	0	232	0
pH value	7.7	10.1	9.3	11.7	5.9
Sulphate-chloride ratio	26.7	34.0	76.0	29.0	
Sulphate-carbonate ratio				2.8	
Percent blowdown				3.1	
Phosphate as PO_4			12.0	70.0	

(*all values expressed in ppm*)

cured from strip mines, having the following proximate analysis:

Moisture	11.6
Volatile	37.7
Fixed Carbon	37.2
Ash	13.5
Sulphur	3.5
Btu, wet	11,064
Btu, dry	12,501

This coal burns freely, with a long flame, is difficult to pulverize and, being non-clinkering, doesn't require the agitating action of an underfeed stoker. Traveling-grate stokers have been found suitable for these conditions and a Coxe unit was selected for this plant. It is 14 ft wide and 20 ft 6 in. long, and a maximum burning rate of about 32 lb per sq ft is obtained on the 287-sq-ft grate. Incidentally, the view of stoker housing and weigh larry in Fig. 1 proves that good housekeeping is possible in plants of this type. The aluminum paint helps by exposing dust.

Furnace Construction

Furnace contour is designed for efficient combustion of low-grade coal. Wide throat, high front arch, and long, low rear arch encourage lean gas from unburned portions of the fuel bed to mix with the richer mixture being released near the front, before this richer gas passes into the tube spaces. Waterwall headers extend the full length of the stoker to form a clinker chill. Baffle arrangement is conventional. Vulcan soot blowers are provided; rear soot hoppers dump onto the end of the stoker through openings in the rear suspended arch.

High volatile content of coal necessitates special measures to assist combustion and prevent smoke. In spite of the fact that the coal used contains about 10% natural moisture, tempering is resorted to, water being added in summer and steam in winter to bring the moisture up to 15%. Just why this practice should make it "burn better" is not known, but theories advanced by Robert H Kuss (*Power*, November, 1937) seem reasonable.

In spite of the retarding action on distillation of volatiles attributed to tempering, rich mixtures present in the first stages of combustion tend to pass into the tube spaces before burning completely, producing smoke and lowering efficiency. Jets of air, introduced across the front arch, direct rising gas back onto the incandescent surface of the fuel bed before finally leaving the furnace. This overfire air is supplied by a separate fan capable of maintaining 6-in. pressure at all times. Steam jets at the corners just below the ignition arch are used when a high degree of smokelessness is compulsory.

The boiler gage board, Fig. 3, contains instruments required to indicate and record each factor affecting performance of the unit. At extreme top is an illuminated pressure gage (Ashcroft-Hancock), and below are ammeter and wattmeter showing fan operation; Hays multiple-pointer draft gage indicating windbox pressure, overfire pressure, furnace draft, draft entering and leaving economizer; and a Brown recording pressure gauge for steam and boiler-feed pressure. Across the middle of the panel are a Bailey steam-flow air-flow meter; a Brown 6-point potentiometer recording temperature of water entering and leaving economizer, exit gas entering and leaving economizer, and saturated and superheated steam; and an electric CO_2 recorder (also Brown). The board also contains combustion-control dials and control buttons for forced- and induced-draft fans.

Bailey combustion-control equipment automatically regulates forced draft and uptake draft according to header pressure. Provision is made for future fuel-feed control with air-ratio adjustment. Feedwater regulators (Copes) control boiler-water level; a Reliance water column fitted with an "Eye-Hye" device makes water line visible at firing-floor level.

The water-conditioning system incorporates a new development in the hot-processing method of softening.

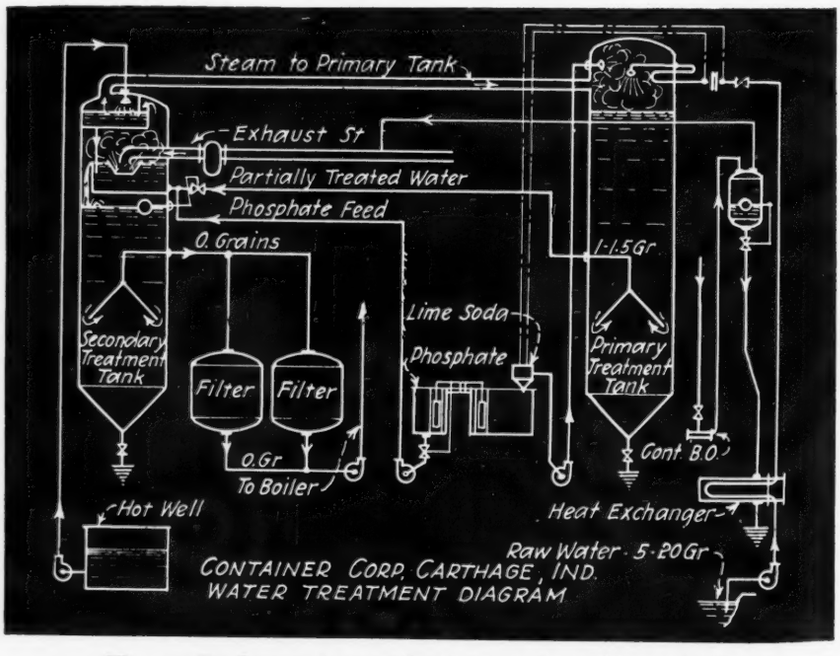
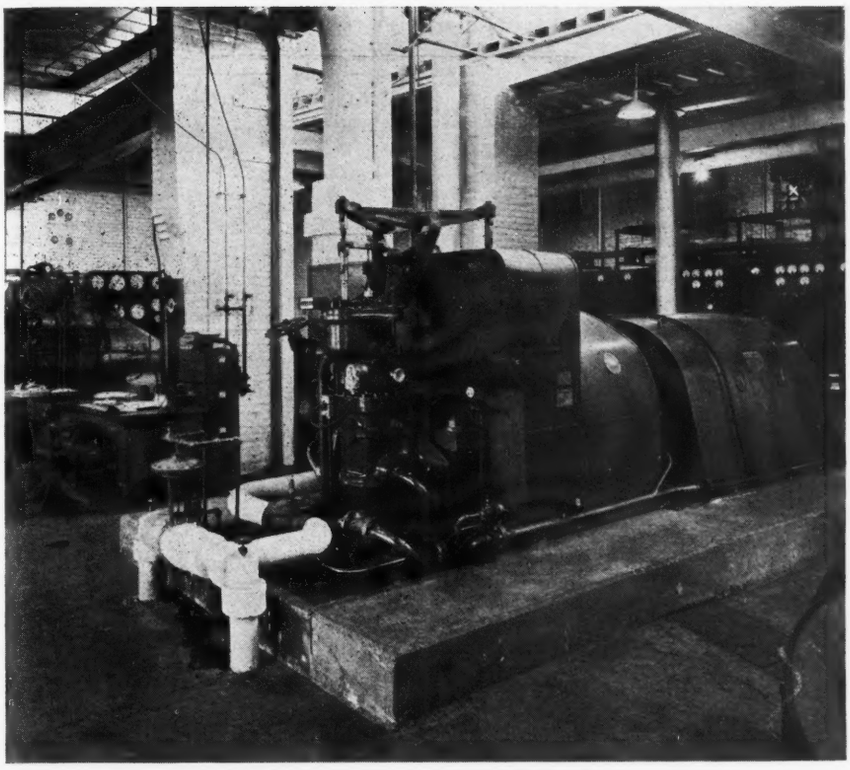


Fig. 3—Feedwater is completely treated outside of boiler



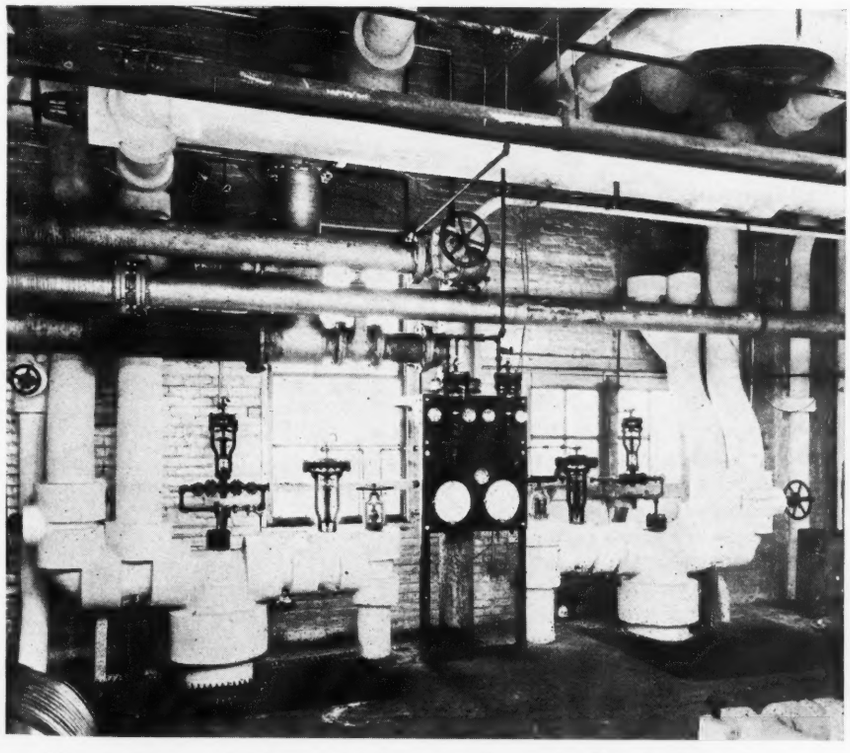


Fig. 4—Two paths from 600 lb to 160 lb—main flow is through topping turbine; reducing valves and desuperheaters handle excess and entire flow when turbine is out of service

An existing 12,000-gph hot-process unit, with tray heater and a 8-ft filter, did not provide for deaeration, handling of oily condensate from paper-mill engine drives, or phosphate after-treatment, and so was considered inadequate for the new boiler. A Cochrane 2-stage hot-process softener, Fig. 3, with two sedimentation tanks and two filters, now handles the job.

In the first stage, a jet heater brings makeup temperature to within 2 – 5 F of steam temperature, and lime and soda ash precipate the hardness down to approximately one grain per gal. Settled water flows by gravity to to secondary treatment tank where it is deaerated by jets and subsequently treated with phosphate, reducing hardness to zero. Soft water then passes through two 8-ft filters with beds of anthracite material. Oily condensate, introduced into the second sedimentation tank, is heated by a jet in a compartment, and then joins the lime and soda effluent for deaeration in the second stage. By handling condensate and makeup in this way, primary and secondary softening, removal of oil from condensate, and deaeration of entire flow is accomplished in one continuously-operated system. Unique also is the introduction of phosphate into the secondary sedimentation tank where remaining hardness is precipitated instead of in the boiler, as is more customary. This means that boilers get crystal clear water of zero hardness, reducing sludge accumulations to a minimum.

Analyses in Table I show conditions at various stages in the treatment circuit. To maintain desired conditions means constant attention, since raw water taken from an adjacent stream is extremely variable, having hardness ranging from 5 – 20 grains. Hourly tests on both treated and raw water make it possible to anticipate chemical changes to some extent. Consulting service on feed treatment is rendered by W H & L D Betz.

Turbine-Generator

The paper mill requires steam at about 160 lb for existing engine drives, and at lower pressure for drying, so if new turbine equipment were considered the double-extraction condensing unit would probably get the call as was the case at Container Corp's Manayunk plant. At Carthage, however, adding a 1500-kw backpressure unit, expanding from 550 to 160 lb, to the existing 1500-kw turbine taking throttle steam at 160 lb and bleeding at 10 lb, gave the equivalent of a 3000-kw double-extraction condensing unit.

The Westinghouse turbine-generator selected is shown in Fig. 4, which also shows the reducing valve and desuperheater arrangement. Day-by-day job of this equipment is to lower pressure and temperature of about 1400 lb per hr of high-pressure steam going direct to process without passing through the turbine for power generation. The reducing station must also be able to handle all plant 160-lb steam requirements should the turbine be out of service. Two complete Swartwout units are installed, with necessary controls and pressure and temperature recorders mounted on a convenient gage board. Water for desuperheating is taken directly from the high-pressure boiler-feed system through a reducing valve. An alarm warns if temperature of steam on low side exceeds setting.

Generator Voltage Toes the Mark

Cayuga Rock Salt Co employs electron-tube regulators to maintain constant voltage on three 300-kva alternators serving a highly fluctuating load

By E S LINCOLN
Consulting Engineer, New York, N. Y.

AT MYERS, N. Y., the Cayuga Rock Salt Co has installed a 1125-hp diesel-electric plant to operate its 1000-ton-per-day rock-salt mine. Three 375 Buckeye diesels are direct connected to 250-kw, 0.80-power factor, 2400-volt Elliott alternators with 7½-kw, 125-volt, V-belt driven exciters. The mine hoist is driven by a 500-hp wound-rotor motor, and this load, imposed on the normal plant load of 200 kw, makes voltage regulation a difficult problem. Severity of load swings is indicated by the section of wattmeter chart, Fig. 2.

Consequence was that much engineering skill went into this job. Voltage regulators are Ward-Leonard automatic electronic units, Fig. 1, which deliver rectified current from alternator to exciter shunt-field coils, thus separately exciting the exciters. Because of the severe load swings and close voltage regulation required, generators in combination with voltage regulators were specially designed and regulation obtained equal to that of a much larger plant. Contract requirements specified that generator voltage should not drop more than 10% from no load to full load, with voltage regulators in service, provided that engine speed did not fall off more than 10%.

Fig. 5 shows the almost instantaneous action of the generator-voltage regulator when 160% load is applied to the generator and when this load is dropped. This oscillogram indicates that the regulator starts functioning during the first half of the decreasing voltage wave, and that normal voltage is restored within 40 cycles. On decreasing load, voltage is restored to normal in 50 cycles. The oscillograms were taken with instantaneous application and removal of load on a 60-cycle circuit, which means that voltage was restored to normal in 2/3 and 5/6 sec respectively.

Difference in amplitude of the voltage waves shown in Fig. 5 for unloaded and overloaded conditions, is due to the fact that the generator was fully saturated at 160% load. Up to 100% of machine rating, amplitude of voltage waves for unloaded and loaded conditions will be within plus or minus 1% of each other.

Values taken from a second oscillograph were used to plot the curves, Fig. 3, which demonstrate ability of the regulators to confine terminal-voltage change, resulting from severe-load applications within a comparatively narrow band. In this instance, two heavily loaded crane motors were started simultaneously and were brought across the line in approximately 3.5 sec.

Current flow in a high vacuum tube depends upon electronic emission from the filament (cathode) to the plate (anode). This electronic emission varies with the temperature of the filament; a cold filament will emit no electrons and no current will flow to the plate, but a hot filament will emit many electrons. If plate voltage is set high enough so that all electrons emitted by the heated filament are attracted to the plate, then maximum current flows in the plate circuit and varies only with the filament temperature. It is this change in filament temperature caused by the generator voltage under control that forms the basic principle of the electronic generator-voltage regulator.

Regulator Circuits

Fig. 4 is a simplified diagram of the regulator circuits. Exciter field coils are energized from the regulator transformer taking power from the alternator. Current from the secondary of this transformer is rectified by tubes *VT3* and *VT4* before going to the field coils. Current can flow from the filament to the plate of each tube. With upward flow of current in the secondary of the regulator transformer, field current flows from the center connection through the field winding and through tube *VT3* from filament to plate and back to the transformer. In this operation, lower half of the secondary winding is in use. With downward flow of current in the regulator-transformer secondary, current

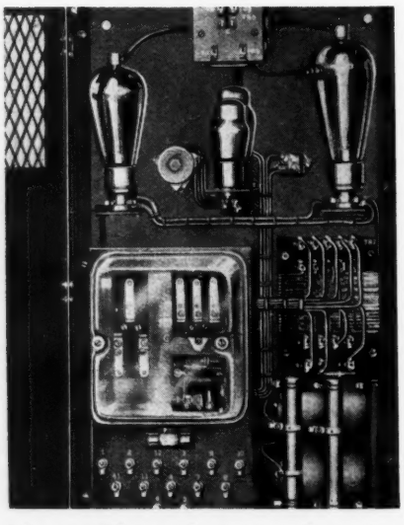


Fig. 1—Electronic automatic generator-voltage regulator

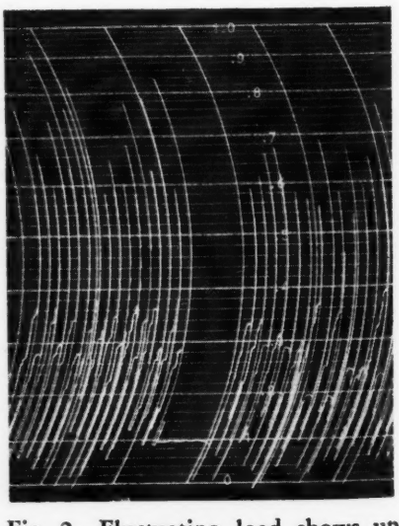


Fig. 2—Fluctuating load shows up on this section of wattmeter chart

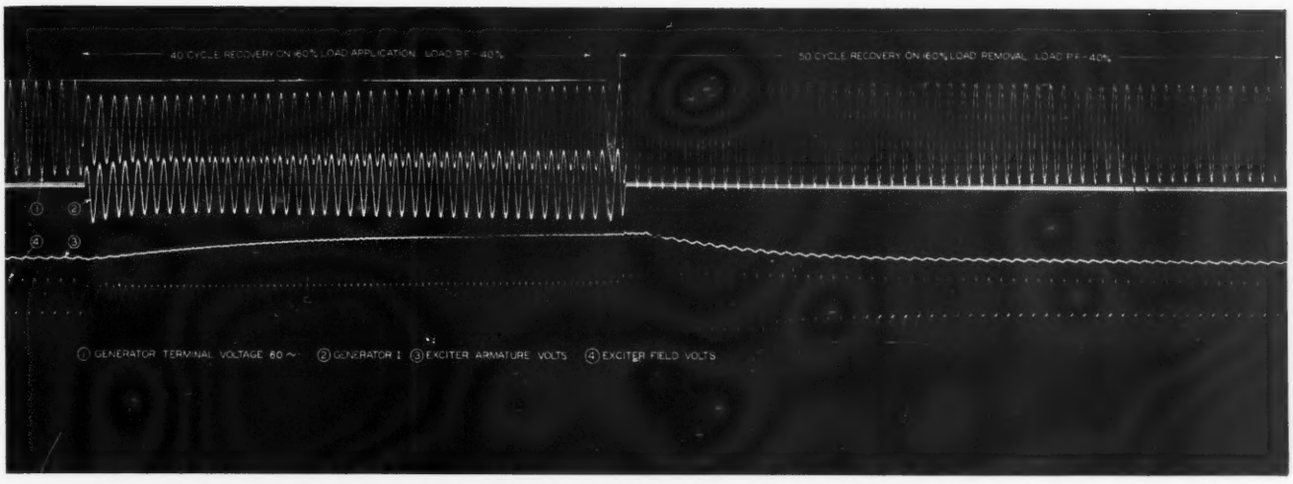

40 CYCLE RECOVERY ON 160% LOAD APPLICATION LOAD P.F. - 80%
50 CYCLE RECOVERY ON 160% LOAD REMOVAL LOAD P.F. - 40%
① GENERATOR TERMINAL VOLTAGE 60 ~ ② GENERATOR I ③ EXCITER ARMATURE VOLTS ④ EXCITER FIELD VOLTS

Fig. 5—Oscillogram shows action of the regulator when 160% load is applied and then dropped

flow to the field coils is in the same direction but from filament to plate of tube *VT4* and back to the top half of the transformer secondary. Current to the exciter field coils is controlled by regulating potential applied to the grid of tube *VT3*. It is only necessary to control voltage of one tube to change the current input into the exciter field from both tubes. The exciter shunt-field winding is highly inductive and is the common load of both tubes. When supplying such a load, the tubes become electro-magnetically coupled.

The grid transformer for tube *VT3* is energized by the top half of the control-transformer secondary and is controlled by tube *VT2*. Potential on the grid of this tube is supplied through tube *VT1*. Filament of this tube is energized by current supplied from the lower section of the control-transformer secondary, primary winding of which connects to the alternator. Thus, an increase or decrease in alternator voltage causes a change in the filament current of tube *VT1* and therefore its temperature, which in turn changes grid voltage of tube *VT2*. This tube controls current supplied to the primary of the grid transformer in turn regulating potential on the grid of tube *VT3*.

Thus, if alternator voltage increases, as happens when load is dropped, filament temperature of tube *VT1* becomes higher with increase of voltage and current from the control transformer. This increases the flow of current of tube *VT1* and changes potential on the grid of tube *VT2*, which in turn, through grid transformer, adjusts potential on the grid of tube *VT3* to decrease the exciter-field current. Decreasing exciter-field current reduces its armature voltage, which in turn reduces current in the alternator field coils to restore line voltage to normal. When load increases, causing a drop in generator voltage, the reverse action takes place.

These regulators may be used with a line-drop compensator for maintaining a constant voltage at some distributing center. Where unbalanced voltages exist, generator voltage can be regulated by connecting controlling tube *VT1* cathode to an average of the three phase voltages. Electronic regulators may be used to control generators operating in parallel, and, under certain conditions, a single regulator can control two or more generators operating in parallel. The electronic regulator, Fig. 1, is protected against short circuits, tube failures, etc., and restores the system to manual control by supplying the exciter field with current from the exciter armature.

Corrective Action

These electron-tube regulators have no insensitive zone and therefore no sensitivity rating. Adjustments are simple and unnecessary after the original installation has been made. These regulators have no continuously moving parts or contacts to wear; after long intervals of service, only tubes need renewal. A positive anti-hunting circuit minimizes overshooting and resulting oscillations of the ac generator voltage.

With the electronic regulator, field forcing is effectively accomplished by ability of the regulator to deliver a voltage across the exciter shunt field in excess of armature voltage. The regulator provides positive overvoltage protection and abnormal voltages cannot be impressed upon the exciter field while the regulator is in use. Generator voltage may be conveniently adjusted over a 5% range when the regulator is operating. On small generators, the exciter may be omitted and the rectifier used directly in the generator field after initial excitation has been provided. Such applications have been made and are mentioned to illustrate the flexibility and the wide range of possibilities of automatic electronic voltage-regulator control applied to ac generators.

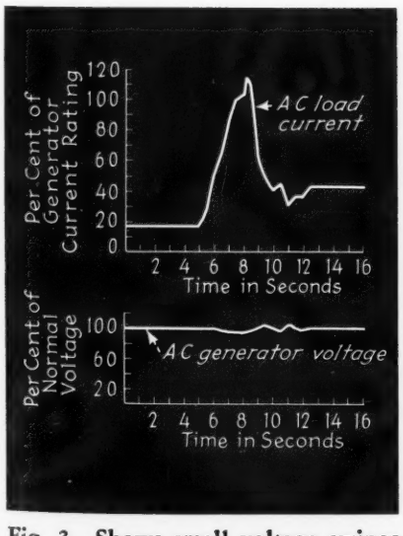


Fig. 3—Shows small voltage swings caused by rapidly varying load

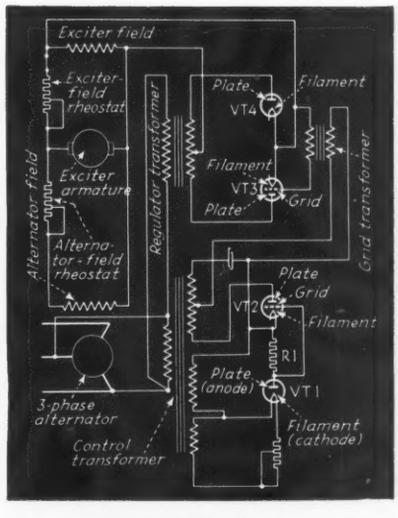


Fig. 4—Simplified diagram of the voltage regulator

Let's Look at the Record

Operating records are a necessity in any well-run diesel plant. Here's a practical, workable plan for keeping them, proved by fifteen years' use

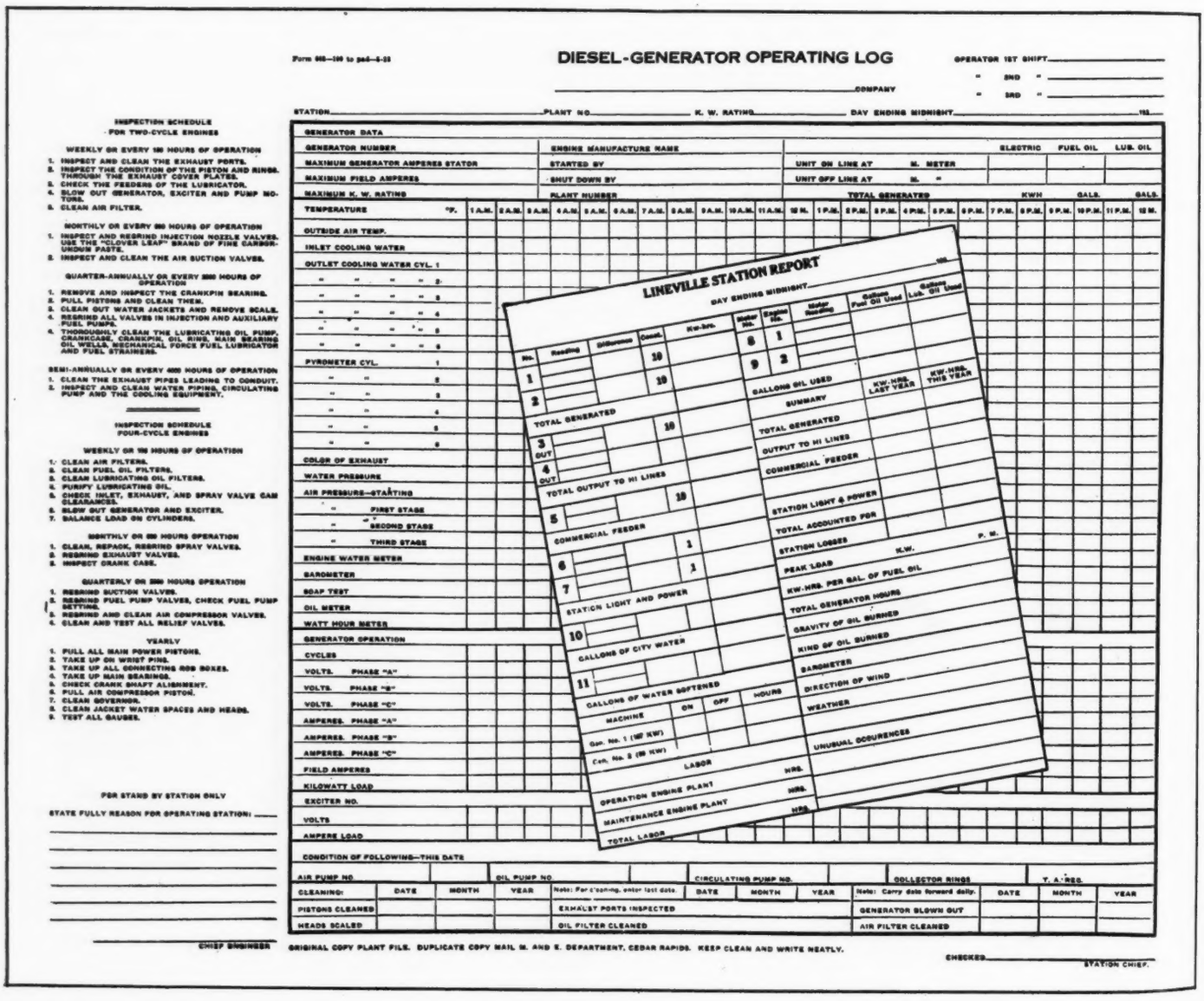
By JOHN M DRABELLE

Mechanical and Electrical Engineer, Iowa Electric Light and Power Co

SUCCESSFUL operation of any power plant depends on adequate records. Over a period of fifteen years, the companies with which the writer is associated have developed a system of records for their several diesel-engine power stations. Naturally, the system is designed to fit conditions as we have met them, but since the same essential features are involved in operation of all diesel plants, there should be much of value to other operators in our system for keeping track of cost.

Records can be divided into two classifications—operating records and accounting records. For operating purposes we have found it advantageous to have a continuous hourly record for each engine and generator that is on the bus delivering power to the system. Typical of this record is the log sheet entitled "Diesel-Generator Operating Log." This gives a comprehensive picture of the day's operation of each engine.

General data appears at the top of the form (see illustration); below, hourly entries show cooling-water and exhaust temperatures. The value of this is clear. As we all know, cooling



DIESEL-GENERATOR OPERATING LOG

INSPECTION SCHEDULE
FOR TWO-CYCLE ENGINES

WEEKLY OR EVERY 100 HOURS OF OPERATION
1. INSPECT AND CLEAN THE EXHAUST PORTS.
2. INSPECT THE CONDITION OF THE PISTON AND RINGS THROUGH THE EXHAUST COVER PLATES.
3. CHECK THE FEEDING OF THE LUBRICATOR.
4. BLOW OUT GENERATOR, EXCITER AND PUMP MOTORS.
5. CLEAN AIR FILTER.

MONTHLY OR EVERY 200 HOURS OF OPERATION
1. INSPECT AND REGRIND INJECTION NOZZLE VALVES. USE THE "CLOVER LEAF" BRAND OF FINE CARBORUNDUM PASTE.
2. INSPECT AND CLEAN THE AIR SUCTION VALVES.

QUARTER-ANNUALLY OR EVERY 2000 HOURS OF OPERATION
1. REMOVE AND INSPECT THE CRANKPIN BEARING.
2. PULL PISTONS AND CLEAN THEM.
3. CLEAN OUT WATER JACKETS AND REMOVE SCALE.
4. REGRIND ALL VALVES IN INJECTION AND AUXILIARY FUEL PUMPS.
5. THOROUGHLY CLEAN THE LUBRICATING OIL PUMP, CRANKCASE, CRANKPIN, OIL RING, MAIN BEARING OIL WELLS, MECHANICAL FORCE FUEL LUBRICATOR AND FUEL STRAINERS.

SEMI-ANNUALLY OR EVERY 4000 HOURS OF OPERATION
1. CLEAN THE EXHAUST PIPES LEADING TO CONDUIT.
2. INSPECT AND CLEAN WATER PIPING, CIRCULATING PUMP AND THE COOLING EQUIPMENT.

INSPECTION SCHEDULE
FOUR-CYCLE ENGINES

WEEKLY OR 150 HOURS OF OPERATION
1. CLEAN AIR FILTERS.
2. CLEAN FUEL OIL FILTERS.
3. CLEAN LUBRICATING OIL FILTERS.
4. PURIFY LUBRICATING OIL.
5. CHECK INLET, EXHAUST, AND SPRAY VALVE CAM CLEARANCES.
6. BLOW OUT GENERATOR AND EXCITER.
7. BALANCE LOAD ON CYLINDERS.

MONTHLY OR 600 HOURS OPERATION
1. CLEAN, REPACK, REGRIND SPRAY VALVES.
2. REGRIND EXHAUST VALVES.
3. INSPECT CRANK CASE.

QUARTERLY OR 2000 HOURS OPERATION
1. REGRIND SUCTION VALVES.
2. REGRIND FUEL PUMP VALVES, CHECK FUEL PUMP SETTING.
3. REGRIND AND CLEAN AIR COMPRESSOR VALVES.
4. CLEAN AND TEST ALL RELIEF VALVES.

YEARLY
1. FULL ALL MAIN POWER PISTONS.
2. TAKE UP ON WRIST PINS.
3. TAKE UP ALL CONNECTING ROD BOXES.
4. TAKE UP MAIN BEARINGS.
5. CHECK CRANK SHAFT ALIGNMENT.
6. PULL AIR COMPRESSOR PISTON.
7. CLEAN GOVERNOR.
8. CLEAN JACKET WATER SPACES AND HEADS.
9. TEST ALL GAUGES.

FOR STAND BY STATION ONLY

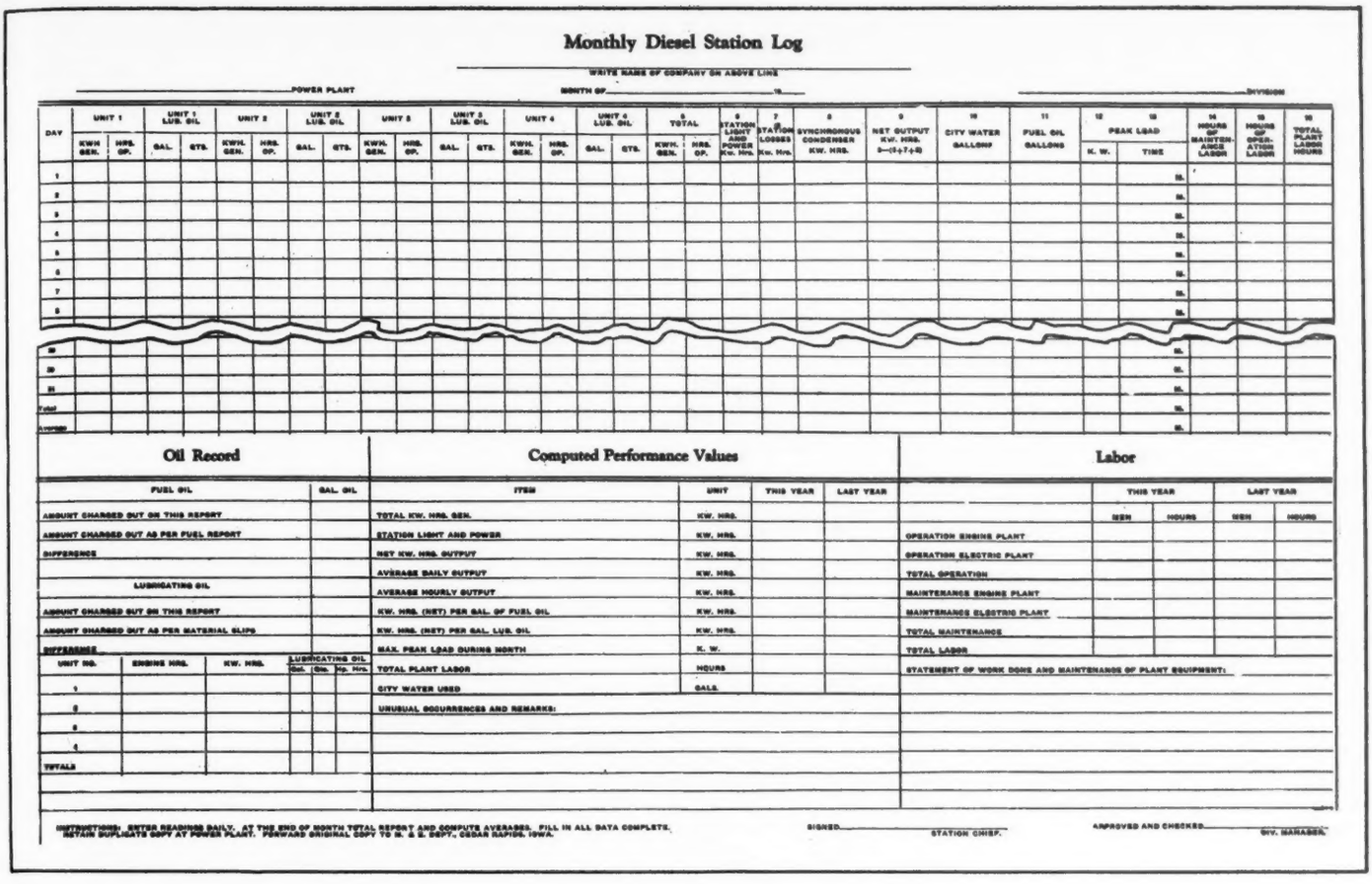
STATE FULLY REASON FOR OPERATING STATION: _____

CHIEF ENGINEER

LINEVILLE STATION REPORT

ORIGINAL COPY PLANT FILE. DUPLICATE COPY MAIL M. AND E. DEPARTMENT, CEDAR RAPIDS. KEEP CLEAN AND WRITE NEATLY.

CHECKED _____ STATION CHIEF.



Monthly Diesel Station Log

WRITE NAME OF COMPANY ON ABOVE LINE

_____ POWER PLANT MONTH OF _____ 19__ _____ DIVISION

DAY	UNIT 1 KWH GEN.	UNIT 1 HRS. OP.	UNIT 1 LUB. OIL GAL.	UNIT 1 LUB. OIL QTS.	UNIT 2 KWH. GEN.	UNIT 2 HRS. OP.	UNIT 2 LUB. OIL GAL.	UNIT 2 LUB. OIL QTS.	UNIT 3 KWH. GEN.	UNIT 3 HRS. OP.	UNIT 3 LUB. OIL GAL.	UNIT 3 LUB. OIL QTS.	UNIT 4 KWH. GEN.	UNIT 4 HRS. OP.	UNIT 4 LUB. OIL GAL.	UNIT 4 LUB. OIL QTS.	5 TOTAL KWH. GEN.	5 TOTAL HRS. OP.	6 STATION LIGHT AND POWER Kw. Hrs.	7 STATION LOSSES Kw. Hrs.	8 SYNCHRONOUS CONDENSER KW. HRS.	9 NET OUTPUT KW. HRS. 9=(5+7+8)	10 CITY WATER GALLONS	11 FUEL OIL GALLONS	12 PEAK LOAD K. W.	13 PEAK LOAD TIME	14 HOURS OF MAINTENANCE LABOR	15 HOURS OF OPERATION LABOR	16 TOTAL PLANT LABOR HOURS
1																										1.			
2																										2.			
3																										3.			
4																										4.			
5																										5.			
6																										6.			
7																										7.			
8																										8.			
30																										30.			
31																										31.			
Total																										32.			
Average																										33.			

Oil Record

FUEL OIL	GAL. OIL
AMOUNT CHARGED OUT ON THIS REPORT	
AMOUNT CHARGED OUT AS PER FUEL REPORT	
DIFFERENCE	

LUBRICATING OIL	
AMOUNT CHARGED OUT ON THIS REPORT	
AMOUNT CHARGED OUT AS PER MATERIAL SLIPS	
DIFFERENCE	

UNIT NO.	ENGINE HRS.	KW. HRS.	LUBRICATING OIL Gal.	Qts.	Kg. Hrs.
1					
2					
3					
4					
TOTALS					

Computed Performance Values

ITEM	UNIT	THIS YEAR	LAST YEAR
TOTAL KW. HRS. GEN.	KW. HRS.		
STATION LIGHT AND POWER	KW. HRS.		
NET KW. HRS. OUTPUT	KW. HRS.		
AVERAGE DAILY OUTPUT	KW. HRS.		
AVERAGE HOURLY OUTPUT	KW. HRS.		
KW. HRS. (NET) PER GAL. OF FUEL OIL	KW. HRS.		
KW. HRS. (NET) PER GAL. LUB. OIL	KW. HRS.		
MAX. PEAK LOAD DURING MONTH	K. W.		
TOTAL PLANT LABOR	HOURS		
CITY WATER USED	GALS.		

UNUSUAL OCCURRENCES AND REMARKS:

Labor

	THIS YEAR MEN	THIS YEAR HOURS	LAST YEAR MEN	LAST YEAR HOURS
OPERATION ENGINE PLANT				
OPERATION ELECTRIC PLANT				
TOTAL OPERATION				
MAINTENANCE ENGINE PLANT				
MAINTENANCE ELECTRIC PLANT				
TOTAL MAINTENANCE				
TOTAL LABOR				

STATEMENT OF WORK DONE AND MAINTENANCE OF PLANT EQUIPMENT: _____

INSTRUCTIONS: ENTER READINGS DAILY. AT THE END OF MONTH TOTAL REPORT AND COMPLETE AVERAGES. FILL IN ALL DATA COMPLETE. RETAIN DUPLICATE COPY AT POWER PLANT. FORWARD ORIGINAL COPY TO M. & E. DEPT., CEDAR RAPIDS, IOWA.

SIGNED _____ STATION CHIEF. APPROVED AND CHECKED _____ DIV. MANAGER.

water is an extremely important item in the safe operation of a high-temperature, high-pressure engine such as the diesel. Cooling water must not stop. Its supply must be continuous, and proper entering and leaving temperatures must be maintained. Likewise, records of temperature of gas leaving each cylinder indicate relative balance of load and fuel-injection-mechanism performance on each of the several cylinders. Low exhaust temperature on one cylinder and high or excessive exhaust temperature on another means that one is loafing and the other is overloaded. Overloading of a power cylinder means the possibility of cracked heads, pistons, and stuck piston rings, with heavy maintenance expense as the inevitable result.

Air Pressures Recorded

For air-injection engines, performance of the compressor supplying injection air is important, so these pressures are recorded hourly. Failure of the valve mechanism in any one cylinder can be readily detected and proper corrective means applied before failure of air supply or damage to the compressor. Hourly consumption of oil and hourly generator output gives a continuous check of engine performance under the varying loads it carries during the day.

Under the classification of generator operation, the log sheet carries space for hourly listing of cycles, phase volts, phase amperes, and field amperes. With almost universal use of electric clocks, maintenance of close frequency control and regulation is highly essential, and voltage regulation is vital to the satisfactory operation of many other appliances connected to the lines. Recording these figures is an aid to maintaining good service.

Keeping track of amperes flowing in the generator field protects against slow roasting from continuous overload due to low power factor or improper adjustment of generator-field rheostats, when two units are operating in parallel on the same bus.

Space is provided at the bottom of the log sheet for setting down the date when routine cleaning operations (pistons, heads, exhaust ports, oil filters, air filters, generators) are completed. These jobs are vital parts of maintenance procedure, and only by doing them at regular intervals can best results be obtained from a diesel engine.

Station Reports

So much for the daily engine log sheet. Where several stations are operated on a system, a simple daily report summarizing production data is helpful. Such a report is shown superimposed on the log sheet. The actual form of the report varies since the number of units installed and the number of outgoing feeders changes from station to station, but it is essentially a record of the generator meters and other meters connected to transmission lines and commercial feeders together with a record of station light and power. This latter is often overlooked and so poorly selected auxiliaries, consuming power excessively, go unnoticed. Recording auxiliary power also shows when improper maintenance of auxiliaries causes increased consumption.

Each engine on the system has its own fuel meter, and daily Station Reports list oil consumption separately. These figures can then be matched with kilowatt-hours generated by each machine, to get performance data. Overall station performance is set up strictly on net output; namely, gross generation less station light and power.

Monthly Diesel Station Log

On the "Monthly Diesel Station Log," illustrated at the top of this page, each Station Chief records data from the daily "Station Report" along with certain information from the "Diesel-Generator Operating Log." This produces a daily and monthly summary of kwhrs generated, hours of operation, and lubricating-oil consumption for each unit. It also shows total gross generation, station light and power, station losses, current consumed by synchronous condenser if one is provided, and net output of the station together with a record of city water purchased,

fuel oil used, maximum peak load and time of occurrence, and labor hours.

From this data, the Chief computes the performance figures shown at the bottom of the sheet. Fuel-oil and lubricating-oil record is checked by gaging tanks and correcting to 60 F, the API standard. This backs up records from engine fuel meters. Labor is divided into operation and maintenance and is further subdivided between operation and maintenance of prime movers and operation and maintenance of electrical apparatus.

For several years past, the Oil and Gas Power Division of the American Society of Mechanical Engineers has been collecting data on oil-engine operating costs. Naturally this data varies widely as to certain items of cost. This is largely due to the fact that not all people put the same items in the same pigeonhole. It is easy to over account and it is also easy not to account at all.

The following classification of accounts has been used and subject to gradual development over the past 15 years by the companies with which the writer is associated. These accounting classifications reduce to the lowest possible number the various classes of accounts and yet experience indicates that these are entirely adequate, at least for our own use. The accounts, some of which are self-explanatory, are defined as follows:

Diesel-Electric-Plant Maintenance—includes cost of material used, labor employed and other expenses of repairing (a) equipment used in converting internal-combustion-engine power into electricity and in delivering to the switchboard the electricity produced, and, (b) structures housing or supporting such equipment.

Diesel-Electric-Plant Superintendence and Operating Labor—includes costs of supervision and labor employed in operating plant and equipment used in converting internal-combustion-engine power into electricity, and in delivering to transmission lines and local distribution feeders the electricity produced.

Diesel-Electric Plant Fuel.

Diesel-Electric Plant Water—includes cost of water and treatment.

Diesel-Electric Plant Lubricants.

Diesel-Electric Plant Miscellaneous Expenses—includes cost of material used and expenses incurred in operation of diesel-electric plants not properly chargeable to other accounts.

A monthly report form known as "Diesel-Electric Generating Expenses and Production Statistics" (illustrated) is prepared from the charges classified above. This form gives the Station Chief his costs for each item matched against figures for the same month last year, and the year's costs accumulated to date, against the same data for last year. Kilowatt hours generated are broken down into gross generation, station light and power, station losses, and net output; figures being given for the current month and accumulated months to date, both being compared with last year.

With generating expense in dollars, and kwhrs net generated both given, costs in cents per kwhr can be readily derived. This is shown in the same comparative fashion as the previous sets of statistics.

Miscellaneous production statistics include maintenance labor hours, operating labor hours, gallons of fuel oil and lubricating oil, kwhrs net per gal. of fuel oil and per gal. of lubricating oil. Experience shows this to be a readable, convenient and adequate cost picture of station operation.

Cost Data Important

Diesel-engine cost data has been subject to a great deal of criticism, owing to the loose manner in which much of it has been given. Thus we often hear of current being generated for 4 mills only to find that this is only fuel-oil cost of close generation. Cost of lubricating oil, chemicals for water softening, and treatment are often omitted or neglected even though the success of any diesel operation depends on a full and complete cost statement. It is total money out-of-pocket and total generation available for use or sale for which we are all directly responsible in the long run. Careful use of a relatively simple system of record-keeping and accounting will do much to improve diesel-plant operation and to eliminate many of the criticisms now directed at diesel-engine cost data.

IT *is well for a man to respect his own vocation whatever it is, and to think himself bound to uphold it, and claim for it the respect it deserves*—Dickens.

DIESEL-ELECTRIC GENERATING EXPENSES AND PRODUCTION STATISTICS

_____ DIVISION

GENERATING EXPENSES

GENERATING STATION

	MONTH OF			MONTHS TO DATE		
		INCREASE OR DECREASE AMOUNT	%		INCREASE OR DECREASE AMOUNT	%
MAINTENANCE						
OPERATION						
SUPERINTENDENCE AND LABOR						
FUEL						
WATER						
LUBRICANTS						
MISCELLANEOUS EXPENSES						
TOTAL OPERATION						
TOTAL GENERATING EXPENSES						
ALLOCATION TO DEPARTMENTS						
ELECTRIC DEPARTMENT						
HEATING DEPARTMENT						
TOTAL GENERATING EXPENSES						

KILOWATT-HOURS GENERATED

KILOWATT-HOURS GENERATED						
STATION USES AND LOSSES						
STATION LIGHT AND POWER						
STATION LOSES						
TOTAL STATION USES AND LOSSES						
NET STATION OUTPUT						

COST IN CENTS PER KILOWATT-HOUR NET STATION OUTPUT

MAINTENANCE						
OPERATION						
SUPERINTENDENCE AND LABOR						
FUEL						
WATER						
LUBRICANTS						
MISCELLANEOUS EXPENSES						
TOTAL OPERATION						
TOTAL GENERATING EXPENSES						

MISCELLANEOUS PRODUCTION STATISTICS

MAINTENANCE—LABOR HOURS						
OPERATION—LABOR HOURS						
GALLONS OF FUEL OIL						
AVERAGE COST PER GAL. OF FUEL OIL						
GALLONS OF LUBRICATING OIL						
KW-HRS. NET STATION OUTPUT PER GALLON OF FUEL OIL						
KW-HRS. NET STATION OUTPUT PER GALLONS OF LUBRICATING OIL						

How to Calculate Turbine Performance

Figuring steam rate, temperature and load for back-pressure and extraction turbines is simple if you follow the examples given here

By R P JOHNSON
Turbine Engineer, Westinghouse Electric & Mfg Co

PERFORMANCE CURVES of automatic-extraction turbines or simple condensing or backpressure units yield valuable information to the operator who knows how to apply several simple calculation procedures.

A typical performance curve for a non-extraction backpressure unit is shown in Fig. 1. Present practice of turbine designers is to submit performance information in table form, giving guarantees in lb of throttle steam per kwhr at generator terminals, for quarter, half, three-quarters, full, and one-and-one-quarter loads. Guarantees include all losses in the generator, direct-connected exciter if included, and mechanical losses.

In most cases, the engineer is interested in throttle flows in pounds per hour, and curves are usually submitted on this basis (see Fig. 1). An advantage of having performance information in curve form is that steam flows at intermediate-load points can be ascertained quickly.

It is often necessary to know temperature of steam leaving the turbine exhaust. To determine this temperature the operator has to know (1) overall efficiency of the turbine-generator unit, (2) the mechanical losses, and (3) generator efficiency. If accuracy is required exhaust temperature should be obtained from the turbine designer but it can be calculated fairly closely from the performance curve of the unit. Theoretical steam-rate tables calculated from a large Mollier diagram simplify this computation. If they are not available, theoretical turbine steam rate may be calculated by taking the adiabatic expansion from throttle pressure to the exhaust-steam condition, and then dividing the Btu equivalent of a kwhr by this figure, as described later. All turbine designers use 3412.75 Btu as heat equivalent of a kwhr.

For the load at which exhaust temperature is desired, read guaranteed throttle flow from the performance curve. Lb per kwhr may be obtained by dividing. Then to obtain overall efficiency of the turbine-generator unit, divide theoretical steam rate by lb per kwhr guaranteed.

The adiabatic heat drop from throttle condition to exhaust pressure is obtained by following vertically downward on the Mollier diagram. Multiply this value by the turbine blade efficiency (overall efficiency corrected for generator and exciter efficiencies and mechanical losses) and the result is Btu converted into mechanical energy by the actual turbine.

The Btu value thus obtained is subtracted from heat content of the steam at throttle and the result is heat content of steam at exhaust. Referring again to the Mollier diagram, heat content and exhaust pressure lines intersect at exhaust-steam temperature.

Steam diagrams are all based on absolute pressures; when gage pressures are used correction should be made.

TABLE I

Load, percent	25	50	75	100	125
Load, kw	500	1000	1500	2000	2500
Power factor, per cent	80	80	80	80	100
Steam rate, lb. per kwhr at generator terminals	35.07	24.45	25.11	24.10	24.63
Throttle flow, lb per hr.	17,535	27,450	37,665	48,200	61,576

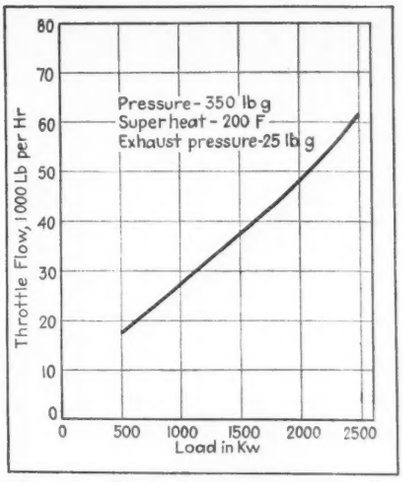


Fig. 1—Typical performance for back-pressure turbine without extraction

EXAMPLE

Assume the following conditions:

Turbine rating	2000 kw
Throttle pressure	350 lb
Temperature at throttle	636 F
Exhaust pressure	25 lb
Atmospheric pressure	14.7 lb

Assume the guarantees of the above turbine generator unit are as given in Table I (same turbine as Fig. 1).

Exhaust Temperature

Temperature of steam at exhaust is desired when the turbine is carrying a load of 2000 kw. Referring to the theoretical steam-rate table, a turbine operating with steam at 350 lb and 636 F (200 F superheat), and exhausting at 25 lb backpressure has a theoretical steam rate of 16.97 lb per kwhr. If a table is not available, the theoretical steam rate of the turbine may be found by referring to a Mollier diagram.

Heat content of steam at 364.7 lb abs and 636 F is 1329.8 Btu per lb, with an entropy of 1.62. Expanding with constant entropy to 39.7 lb abs, the heat content becomes 1128.0 Btu per lb. Then 1329.8—1128.0=201.8, the heat available for transformation into mechanical energy. The theoretical steam rate of the turbine is:

$$\frac{3412.75}{201.8} = 16.97 \text{ lb per kwhr}$$

On smaller Mollier diagrams, Btu values can not be read past the whole number, but tenths of a Btu can be estimated closely enough so that calculated theoretical steam rate is exact to tenths of a lb.

The overall efficiency of the unit carrying a load of 2000 kw is:

$$\frac{16.97}{24.10} = .704 \text{ or } 70.4\%$$

This overall figure includes generator efficiency, exciter efficiency and mechanical efficiency.

Blading Efficiency

The operator does not usually have the exact data covering these individual efficiencies. The combined efficiency of the generator and exciter, including all mechanical losses, varies from 93% at low loads to 96% at full load. To arrive at turbine blading efficiency, divide the overall efficiency of the complete unit by combined generator, exciter and mechanical efficiency. Assuming this efficiency to be 95.5%:

$$\frac{.704}{.955} = .737 \text{ or } 73.7\%$$—estimated internal efficiency or blade efficiency.

Referring again to theoretical heat value given up by the steam and converted to mechanical energy, namely 201.8 Btu:

$201.8 \times .737 = 148.72$ Btu per lb

Then 1329.8—148.72=1181.08 Btu per lb, heat content of exhaust steam.

On the Mollier diagram, take the point at which the 1181.08-Btu line crosses the 39.7-lb pressure line and find approximately 22 F superheat in the exhaust steam. This represents a temperature of 288 F. As mentioned previously, this figure is not exact, but is close enough for most work.

For automatic-extraction turbines typical performance curves are shown in Fig. 2, giving steam-flow values to one-and-one-quarter load on the turbine, representing unity-power-factor rating on the generator. The broken "cut-off line" on the performance curve indicates the limit of constant extraction pressure. Beyond this line an increase in extraction pressure occurs. The cut-off line extends from the point of intersection of the zero-extraction line and the full-load 80%-pf line to the one-and-one-quarter load line at 2500 kw. Extracting a quantity of steam less than indicated by the cut-off line passes a flow of steam to the low-pressure section of the turbine in excess of that for which extraction pressure can be maintained by the regulator, and extraction pressure becomes higher than normal.

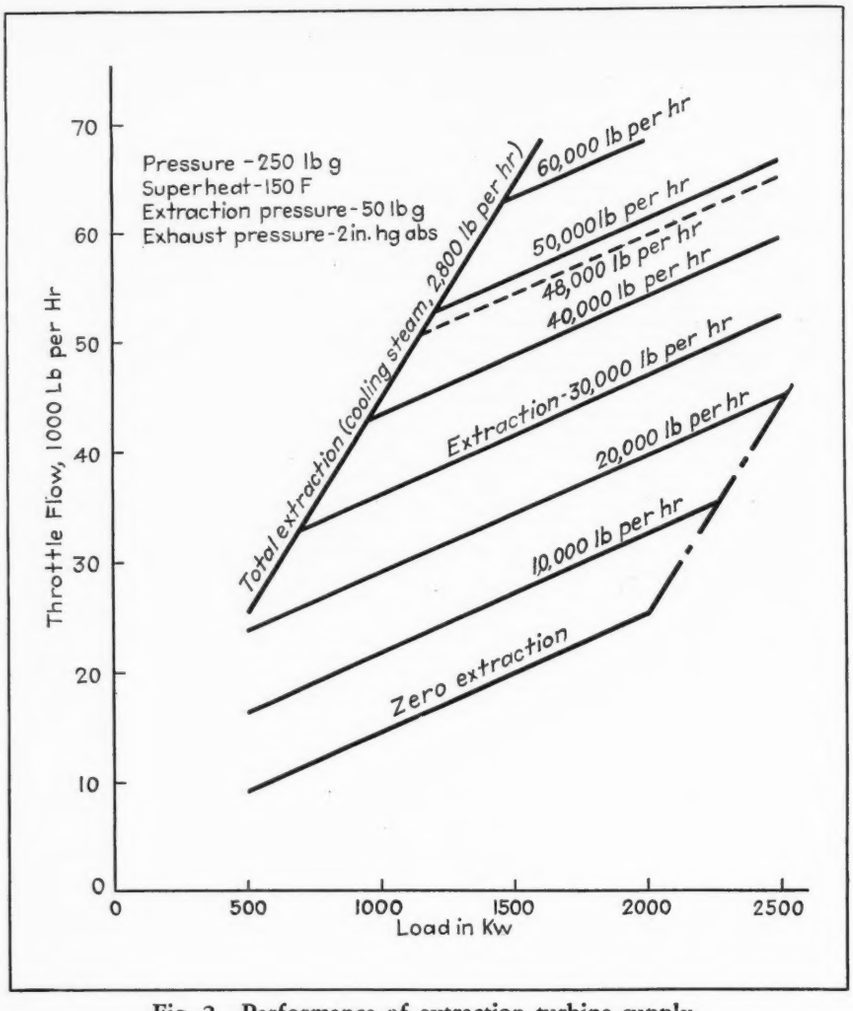


Fig. 2—Performance of extraction turbine supplying varying amounts of steam at constant pressure

The zero-extraction line indicates throttle flows when the regulator is maintaining extraction pressure but without steam flowing from the opening. Lines of constant extraction indicate throttle flows when steam is being extracted at constant pressure.

The "total extraction line" indicates extraction limits of the particular turbine at various loads. For instance, minimum load that could be carried on the 2000-kw machine, while extracting 50,000 lb per hr, is 1200 kw.

Maximum Extraction

The amount of steam that can be extracted at a particular load is also obtained from this curve. Throttle flow at 1500-kw load with maximum extraction is, for example, 64,000 lb per hr. The only flow passing to exhaust is steam to cool low-pressure blading, for this turbine 2800 lb per hr. Therefore, the difference between throttle flow and cooling steam is the maximum extraction, 61,200 lb per hr.

To establish an intermediate line of constant extraction from the information given on the performance curve, only three points need be fixed. Constant-extraction lines are parallel and an equal distance apart; interpolation can be used with fairly accurate results. By a few simple calculations they may be more accurately established.

The throttle flow at 2000-kw load, zero extraction, is 25,300 lb per hr. The throttle flow at any other given extraction line, and at 2000-kw load may be used, for example, the 10,000-lb-per-hr extraction line. The throttle flow at 2000-kw load when extracting 10,000 lb per hr is 32,500 lb per hr. Then the steam that would have to be added to the zero-extraction flow in order to be able to extract 10,000 lb per hr would be:

32,500—25,300=7200 lb per hr

$$\frac{7200}{10,000} = .72$$

known as the "extraction factor," a constant that may be used at any load point. Then:

$.72 \times 48,000 = 34,560$ lb per hr

of steam that would have to be added to the zero-extraction throttle flow regardless of load. At 2000 kw, when bleeding 48,000 lb per hr:

34,560+25,300=59,860 lb per hr

which establishes one point of the 48,000 lb extraction line. The zero-extraction line also indicates that the throttle flow at 1000-kw load is 14,600 lb per hr, and:

14,600+34,560=49,160 lb per hr

which is the throttle flow at 1000-kw load when extracting 48,000 lb per hr.

A straight line can be drawn between these two points, to intersect the total extraction line at a throttle flow equal to the amount extracted plus the cooling steam. In this case, it would be:

48,000+2800=50,800 lb per hr

As in the case of the non-extraction turbine, the temperature of the exhaust may be determined by the procedure already described, using the zero-extraction performance for determining machine efficiency. The results obtained are only approximate since the performance data given include estimated generator, exciter and mechanical efficiencies.

In heat-balance studies, a turbine is sometimes required to extract a maximum quantity of steam automatically at constant pressure, this bled steam to have a specific temperature. The turbine may exhaust to a condenser or to a process header against backpressure and the exhaust steam may also be required to have a certain temperature. Specific initial steam conditions must be applied to obtain the temperatures desired. For these cases, consult turbine manufacturers who have necessary turbine efficiency data to calculate the conditions desired.

However, where steam generating equipment is already on hand, and a certain capacity turbine is required with automatic extraction of a quantity of steam to process, the temperature of the bled steam can be determined approximately from extraction performance curves.

Extraction Temperature

Referring to Fig. 2, assume that it is desired to know the approximate temperature of the extracted steam when carrying a load of 1600 kw. The theoretical steam rate from the throttle to the extraction point, that is, from 250 lb, 150 F superheat, to 50 lb is 26.74 lb per kwhr. If a theoretical steam-rate table is not available, this value may be calculated from the Mollier diagram as already described.

The flow indicated by the intersection of the 1600-kw load line and the total-extraction line is 68,000 lb per hr:

$$\frac{68{,}000}{1600} = 42.50 \text{ lb per kwhr}$$

representing the steam rate when carrying 1600 kw and with a minimum of steam passing to the low-pressure stages of the machine. Then:

$$\frac{26.74}{42.50} = .629 \text{ or } 62.9\%$$

the overall efficiency of the machine to the extraction opening. Dividing this figure by .955% in order to allow for the approximate efficiencies of the generator exciter and mechanical factors:

$$\frac{.629}{.955} = .659 \text{ or } 65.9\%$$

the approximate efficiency of the turbine to the extraction opening.

The heat content of the steam at the throttle pressure and total temperature of 264.7 lb, 150 F superheat is 1293.6 Btu per lb and the entropy is 1.619. Expanding with constant entropy to 64.7 lb, the heat content at the latter pressure is 1165 Btu per lb. Then:

1293.6—1165=128.6
128.6×.659=84.75 Btu

consumed by the turbine from the throttle to extraction opening in producing mechanical energy and:

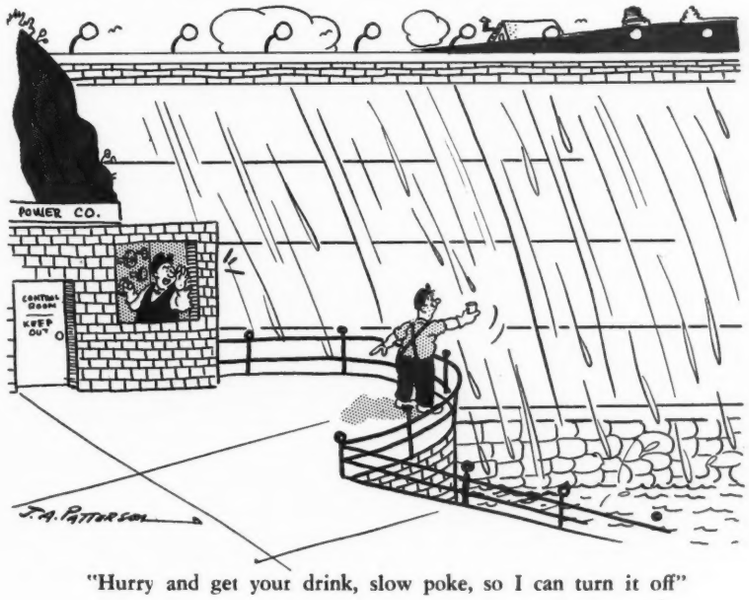
1293.6—84.75=1208.85 Btu per lb

remaining in the extracted steam.

Finally, with a heat content of 1208.85 Btu per lb and a pressure of 64.7 lb the Mollier diagram indicates that steam at the extraction opening has a superheat of 55 F, or a temperature of 352 F.

Exhaust Lines

Remember George C Green, machinist of Lambertvile, N. J., mentioned as helping Chief Engineer Sutton erect the new diesel at the Pillar of Fire plant (*Power*, September, 1938)? Well, he recently broke into the front page by crossing the country (4600 miles) in a 1-cyl, 10-hp, 1904 Oldsmobile, including a climb to the summit of Pike's Peak, 14,109 ft high. Mr. Green acquired his venerable vehicle in 1907 and has kept it in running shape ever since, but lack of a speedometer keeps him from knowing how many miles this mechanical Methuselah has ground out.



"Hurry and get your drink, slow poke, so I can turn it off"

Hams Hall Power Station, Birmingham, England, will have the largest cooling tower in the world, capable of cooling a mere 5,000,000 gal. every hour.

Schoolboys learn of Robert Fulton as inventor of the steamship even thought historians mumble in their beards about John Fitch and others claimed to have beaten him to it by a matter of years. All these efforts seem downright modern however, compared to that of the unknown adventurer described by F O L Chorlton in his presidential address before the Manchester Association of Engineers. As reported in the *Steam Engineer* (London), he said "Mention is made in documents from the Royal Archives in the castle of Simancas in Castile, of a successful attempt to move a ship in the harbour of Barcelona in 1543, by means of steam-driven paddle wheels. Details are not given, and as the experiment was frowned upon by the religious authorities, it was not pursued.

Russians are now digging coal with water—a 220-lb per sq in. stream from a hydraulic monitor cuts into the face of the seam and washes the coal into a drain for hoisting to the surface.

Lubricating by Bottle and Ring

Bottle, ring, chain and collar oilers are mighty handy devices, but they can't be used indiscriminately. Here are blueprinted the uses and operation of this important class of lubricating equipment

By JAMES I CLOWER

Associate Professor of Machine Design
Virginia Polytechnic Institute

TWO PREVIOUS ARTICLES, May and August *Power,* began a general inquisition of lubrication devices. The latter article in August spread butter on bread by showing what drop-feed oilers are and how they work. This month's article progresses to another important class of lubricating equipment.

Bottle oilers, Figs. 1 to 3, comprise an inverted oil-reservoir bottle with threaded neck, a base with integral shank, and a steel or brass feed spindle. In Fig. 1, the bottle oiler is supported on the bearing cap so that the lower end of the spindle rests on the journal. As the journal revolves, the bearing becomes warm and heat is transmitted through the spindle to the air above the oil in the bottle. This heat causes the air to expand, which, with an almost imperceptible pumping action of the feed spindle, forces oil to creep slowly down the spindle to the bearing.

Bottle Oilers

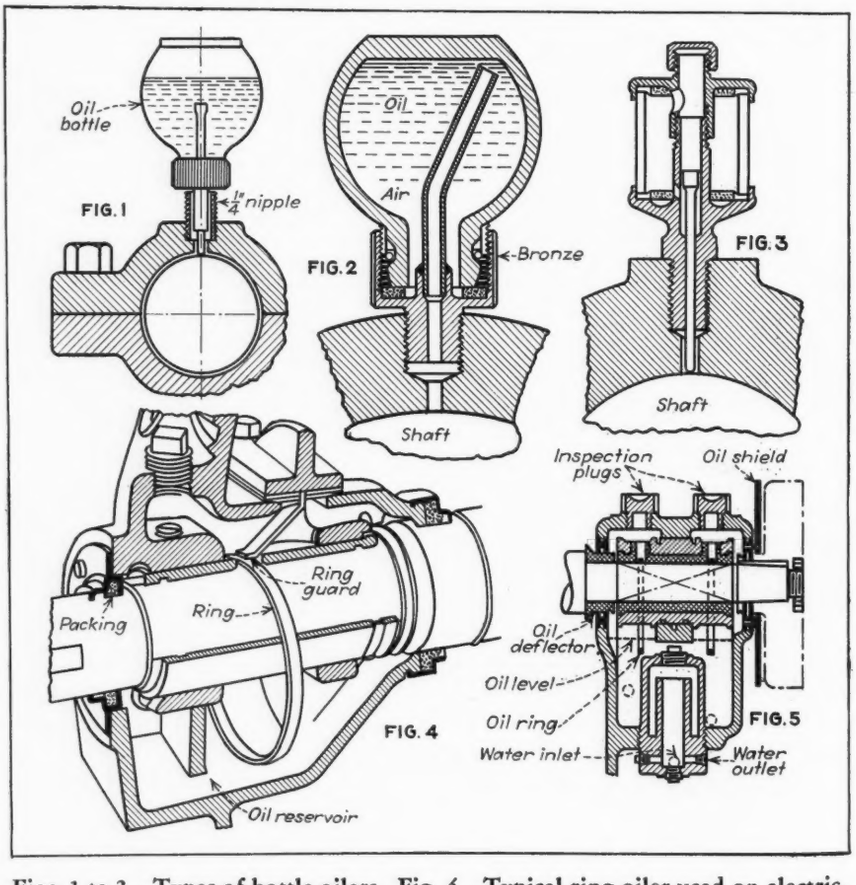
A special design of bottle oiler for loose pulleys is shown in Fig. 2. As the pulley revolves, oil is thrown outward by centrifugal force. Feeding depends on periodic expansion and contraction of air within the bottle. A rise in temperature causes the air to expand, thereby forcing out a small quantity of oil. A subsequent drop in temperature causes the air to contract, permitting additional air to come into the bottle through the tube, replacing the oil previously forced out by expansion of air. To provide air space, this oiler should not be filled more than three-quarters full of oil.

When bottle oilers are attached to bearings by pipe threads, the design of Fig. 3 is commonly used. This type is used on grinders and other machine tools where dust, chips and other impurities are likely to get into the bearing through the connection.

Ring Oiling

Ring, chain and collar oiling are extensively used on horizontal bearings, such as line shafts, electric motors and generators, small steam turbines, centrifugal pumps, main bearings of internal-combustion and steam engines, air compressors, and refrigerating machines.

Fig. 4 shows a typical oil-ring bearing commonly used on electric motors. It comprises a housing, the bottom of which forms an oil reservoir, a ring which rides on and turns with the journal, and the bearing. A slot in the top of the bearing permits the ring to ride on the journal. The ring rotating with the journal carries oil up to the top of the bearing from where it is distributed, by oil grooves and channels, over the bearing length. Any oil that drops or is thrown off the ring or is squeezed from the ends of the bearing, returns to the reservoir and is re-used. Oil seals and slingers prevent leakage, and the guard prevents the ring from becoming displaced. An oil-ring bearing is in effect



Figs. 1 to 3—Types of bottle oilers. Fig. 4—Typical ring oiler used on electric-motor bearings. Fig. 5—Water-cooled ring-oiled bearing for a steam turbine

a self-contained, compact, automatic, circulating oiling system that requires very little attention. Where high-temperature conditions are encountered, the oil reservoir sometimes has a water-cooling system, as in Fig. 5.

Oil-ring bearings are frequently employed in conjunction with circulating systems, the oil being continuously fed to the reservoir by an oil pump. An overflow on the reservoir insures correct oil level at all times.

Fig. 6 shows an oil ring lubricating a silent-chain drive. The ring dips into oil contained in the enclosing case and delivers it to a cup, from where it drains through a pipe onto the chain.

Oil Rings

Oil rings of many cross-sectional forms are used, some of which are shown in Fig. 7. The type shown at *F* and *G* have greater oil-carrying capacity than the others. The type *F* ring has a cross section like a hat with the brim riding on the shaft. Because of its wider contact with the shaft and the slots on its inner periphery, the ring has low slippage on the shaft and high oil-carrying capacity. The laminated ring *G* has been used successfully on large bearings where large oil-carrying capacity is required. In operation, the laminations tend to separate and fill in between with oil to be carried up to the top of the bearing, which gives the ring a much larger oil-carrying capacity than those of conventional cross section.

Ring Capacity

Experience has shown that rings can be depended on generally to supply adequate oil for 4 in. either side of the ring. Thus, bearings more than 8 in. long should have two or more rings. Usual practice is to make the diameter of the ring approximately twice the diameter of the shaft or a little less. One-piece rings are preferable to multipiece designs, which are more likely to foul because of the joints. In any case, the ring should be as smooth and round as possible because rough and distorted rings are likely to stick.

On oil-collar-lubricated bearings, the collar is rigidly fixed to the shaft, and divides the bearing into two parts, Fig. 8. They are especially suitable for low speeds and heavy-bodied oils. Sometimes the collar is forged integral with the shaft, but more frequently it is split and clamped to the shaft for easy removal. Oil-collar bearings are generally provided with scrapers at the top, which remove the oil from the collar and divert it into grooves. The collar will, to a certain extent, maintain axial alignment of the shaft, but cannot be expected to carry any appreciable amount of the end thrust.

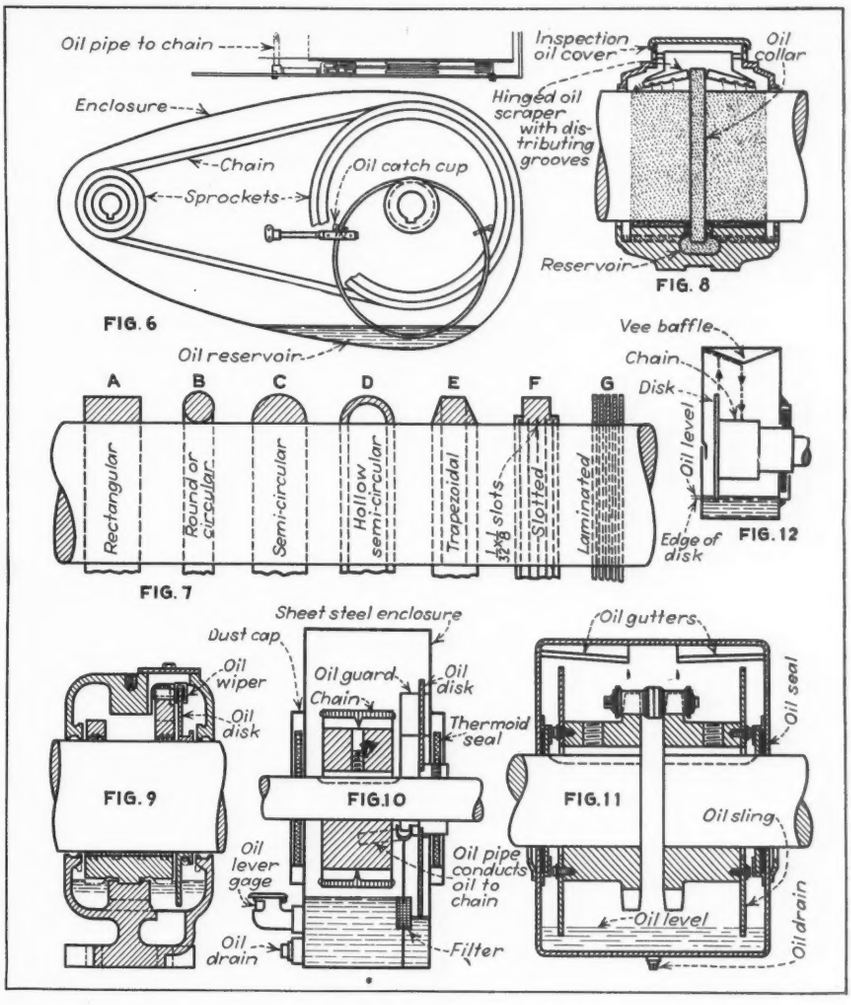


Fig. 6—Ring oiler applied to lubricating a silent chain. Fig. 7—Cross sections of various types of oil rings. Fig. 8—Collar-type oiler. Fig. 9—Disk-type oiler applied to a propeller shaft. Fig. 10—Disk oiler provided with automatic level device applied to a silent chain. Fig. 11—Disk-type oiler on roller chain-type flexible coupling. Fig. 12—Collar oiler applied to a silent-chain drive

Although the oiler, Fig. 9, is commonly spoken of as a disk oiler, it is in effect a collar oiler. Fig. 10 shows a similarly designed oiler for a silent-chain drive. In this type, provision is made to maintain constant oil level at all times. Two especially designed oilers are shown in Figs. 11 and 12. The former is applied to a roller-chain flexible coupling and the latter to a silent-chain drive. In both cases oil is thrown from the oiler by centrifugal force and directed to drop onto the chain.

Oil Level

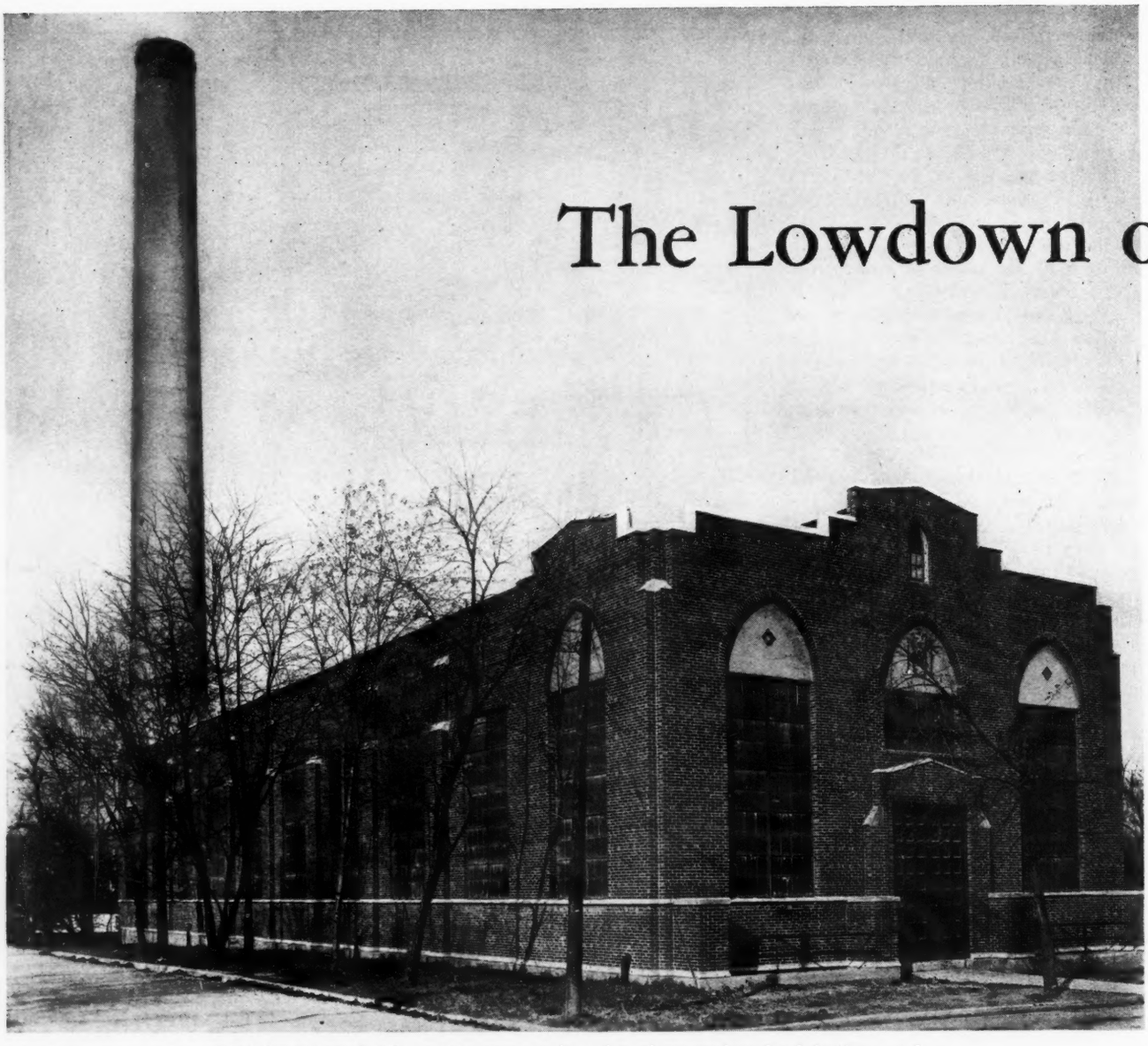
In all cases, it is important to maintain correct oil level in the reservoir of ring-, chain- and collar-oiled bearings. The reservoir should be ample to allow the oil sufficient time to cool before reuse, and it should be of sufficient depth to permit impurities to settle out. A common mistake is to equip bearings with reservoirs of too small capacity. The housing should always be provided with an inspection plug or port and a drain plug at the lowest point in the reservoir. Drain the reservoir and refill with fresh oil periodically if the surroundings are extremely dusty. If the bearing housing is not dust proof, draining may be required every 3 months or oftener.

Contributors

The author expresses appreciation for information used in this article to the Lunkenheimer Co, Cincinnati, O.; Dodge Mfg Corp, Mishawaka, Ind.; Link-Belt Co, Chicago, Ill.; Morse Chain Co, Ithaca, N. Y.; Kingsbury Machine Works, Inc, Philadelphia, Pa.; and The Pure Oil Co, Chicago, Ill.

WE *call things scientific when we don't understand them very well. After we have found out something about them, they cease to be scientific*—Charles F Kettering

The Lowdown on



University of Missouri's power plant has four stoker-fired boilers and two turbine-generators, and is now putting in another boiler and turbine

By R H SOGARD
University of Missouri

REDUCTION of unit costs in a small plant presents problems not encountered in a much larger one. In the small plant, labor, maintenance and supplies are a larger proportion of the total cost than in a larger plant, where fuel may be as much as 85% of total operating expenditure. The smaller-sized steam-generating units and prime movers are usually less economical, and auxiliary requirements are proportionately higher.

The table shows output costs at the University of Missouri power plant for the past seven years. These costs are, as is always the case, influenced by local conditions. Steam-generating equipment—chain-grate-fired, horizontal-drum, water-tube boilers—as installed is inherently not efficient, as three of the four stokers operate with natural draft and limited air control. The plain brick settings are difficult to maintain tight. Gas flow is parallel to the tubes and there is no auxiliary heat-recovery apparatus, such as air heaters or economizers. Furnace volume is comparatively small and complete combustion is difficult to attain at upper ratings. In general, the installation represents low first cost.

Prime movers are small (300 and 600 kw respectively), operate on saturated steam, take considerable auxiliary power for circulating water to jet condensers, and suffer from low vacuum in warm weather because of limited cooling tower capacity.

Until this year, no new and better equipment had been possible, because of limited funds. Two turbine-generators were purchased secondhand in 1932, since additional equipment was essential and money was not sufficient for new machines.

Items 1 and 2 in the tabulation are influenced by others. Item 3, electric generation, shows a gradual rise, due to increase in illumination intensity, a building program in 1935, and greater instructional use of electricity. Water requirements, Item 4, have increased slightly, although they show marked increases in 1934 and 1936, two severe drought years in this locality. Heating steam also has increased, the increase of 1933 over 1932 being due to abandoning a small isolated heating plant and connecting its heating load to the main system. Increases from 1934 to 1937 result from a 1935 building program and also somewhat greater heating requirements (see Item 12).

Unit electric cost, Item 6, fell in 1932 principally because of a decrease in coal price (Item 11). A further de-

Before planning the future, you have to know what's happened in the past—and that means keeping records

Small-Plant Operation

Seven-year Comparative Data From University of Missouri Power Plant

		1931	1932	1933	1934	1935	1936	1937
1.	Fuel cost, dollars	44,152.92	34,490.81	30,880.80	34,584.15	39,188.17	40,508.01	46,305.98
2.	Total cost, dollars	67,481.44	55,486.66	53,511.87	56,606.76	61,406.92	64,220.09	72,838.81
3.	Electric generation, kwhr	1,220,000	1,145,000	1,526,200	1,551,500	1,735,400	1,914,100	2,181,000
4.	Water pumped, 1000 gal	66,116	62,093	61,559	79,320	68,982	83,906	73,767
5.	Heating steam, 1000 lb	73,900	106,439	127,392	147,166	154,169	148,713	145,402
6.	Electric cost, cents per kwhr gross	2.02	1.36	0.76	0.71	0.78	0.82	0.97
6a.	Electric cost, cents per kwhr net	.....	.....	.....	.....	1.00	1.24	1.35
7.	Water cost, cents per 1000 gal. gross	17.2	13.0	11.4	8.65	9.25	8.8	8.3
7a.	Water cost, cents per 1000 gal. net	.....	.....	.....	.....	13.0	12.3	11.7
8.	Steam cost, cents per 1000 lb gross	42.6	29.8	27.4	29.0	27.0	28.5	31.2
8a.	Steam cost, cents per 1000 lb net	.....	.....	.....	.....	32.0	33 5	36.4
9.	Evaporation, lb steam per lb coal	6.2	6.6	7.1	7.4	7.0	7.3	7.3
10.	Coal burned, tons	12,728	13,105	13,387	14,087	15,282	15,857	18,190
11.	Coal price, dollars per ton	3.47	2.63	2.30	2.45	2.57	2.54	2.55
12.	Degree — days	4,207	4,881	4,495	4,742	5,040	5,419	5,544

crease in 1933 was due to installation of the secondhand condensing units mentioned. By 1935, sufficient metering equipment (steam and electric) had been installed so that actual net unit cost (Item 6-A) could be determined. To each of the services, electricity, water, and steam, is charged auxiliary requirements and a proportion of labor, maintenance and supplies. The difference between gross and net unit electric costs illustrates the disadvantage of electric generation by very small condensing units. Increases in unit cost in 1936 and 1937 were caused almost entirely by considerable expenditures for maintenance on these secondhand machines.

The thought naturally occurs that in a combination heating and electric plant, low unit electric cost can be had with back-pressure generation. This has not been possible up to the present because of 150-lb turbine-throttle pressure and a 50-lb heating system. This year, a 275-lb boiler is being installed with a turbine which can exhaust at up to 70-lb backpressure. With these, 2-mill electricity should be possible.

Decreases in water cost (Item 7) are obtained partly from a decrease in coal price and partly from more complete metering of energy to water-pumping equipment; the latter disclosed previous overcharges for water.

Reduction in steam cost is due to decrease in coal price and increase in evaporation per lb of coal, the latter resulting from more careful boiler loading, reduction of excess air, improvement of combustion by turbulence from overfire air and efforts to maintain the brick settings tight.

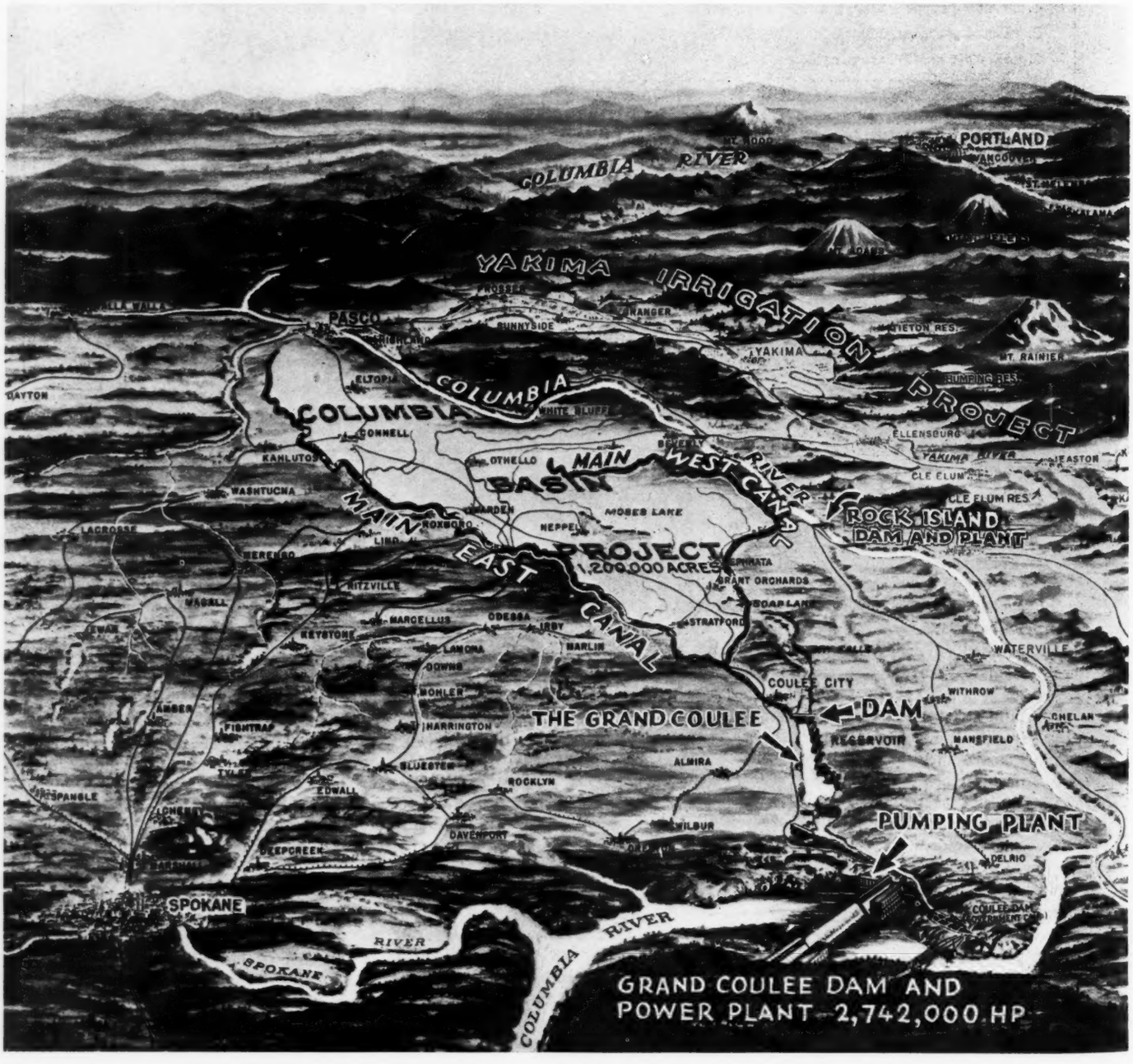
The new equipment being installed should make possible large savings. A future boiler efficiency of 80% as compared with the present annual average of 61% is indicated. The new boiler auxiliary equipment as well as the high quality of the entire steam-generating unit should make for lower boiler-maintenance costs. Use of higher pressure and superheated steam will, of course, improve turbine internal efficiency. Use of exhaust steam for heating will be the largest single gain. Lack of auxiliary requirements on this turbine will also assist. The new turbine exhausting at atmospheric pressure will produce, in conjunction with the better boiler efficiency from the new boiler, electricity at about 20% less than the present low-pressure condensing units with poor summer vacuum. Therefore, we plan to use the new boiler and turbine as base-load equipment throughout the year, taking them out of service only for such inspection or cleaning as necessary.

Facts and Figures on Grand

FOR 3000 years the great pyramid of Cheops in Egypt held the record of being the largest man-made structure in the world, until it was surpassed by Boulder Dam. Before the engineering world had become accustomed to Boulder's superlatives, construction of Grand Coulee was announced. This development will require four times the volume of excavation and three times as much concrete as Boulder Dam. At the moment, Grand Coulee will hold, among others, these "world's largests": dam, power installation, hydroelectric units, pumps, and pumping station.

Grand Coulee owes its existence to the Columbia River, which rises in British Columbia in Lake Columbia just west of the Great Divide, and flows north for about 150 miles. It then makes a sharp westward 180-deg. turn and flows south into the northeastern corner of Washington and continues in approximately a southern direction to the Oregon state line. Then, making a 90-deg. turn, it flows westward into the Pacific Ocean to form the boundary between Washington and Oregon. Columbia River is

Fig. 1—Panoramic view of Columbia-River district and the Grand Coulee project. Pumping plant will provide



Coulee

This gigantic project has been much talked about, because it will hold a lot of world's records when finished. Here *Power* takes a good look at what has been done and what is expected of the dam, hydroelectric project and pumping plant

1210 miles long and, with its tributaries, drains an area of 74,000 sq mi. In its head waters are many lakes that can provide a possible storage of 18,000,000 acre-ft. Lake Kootenay in British Columbia, one of the largest, is 1735 ft above sea level. From the Canadian border to its mouth the river has a fall of 1300 ft.

At the site of Grand Coulee dam, flow normally varies from 17,000 to 492,000 sec-ft, amounting to an annual run-off of 80,000,000 acre-ft. In the flood of 1894, flow reached 725,000 sec-ft at Grand Coulee. At Bonneville, which is at tide water, flow has a normal range of 43,000 to 800,000 sec-ft, with a peak of 1,170,000 sec-ft in 1894. Within the United States, projects on the Columbia River and its tributaries provide for installation of 16,500,000 hp and a possible water-storage maximum of 20,000,000 acre-ft, of which over 5,000,000 acre-ft will be impounded behind Grand Coulee Dam. Boulder Dam reservoir has 30,500,000 acre-ft of storage capacity, or over 10,000,000 acre-ft more than all the possible storage on Columbia River in the United States.

irrigation water for 1,200,000 acres

Geologists tell us that about 25,000 years ago, a great ice cap came down from Canada and blocked the Columbia River below the present site of Grand Coulee Dam (see panoramic map, Fig. 1). Behind this ice dam a large lake formed and overflowed the canyon walls, causing the river to take a new course and cut a great gorge, now known as Grand Coulee. Result was that about 40 cu mi of silt was spread out over the flat country shown on the map as Columbia-Basin Project. When the ice dam melted, flow again followed the former channel and left Grand Coulee dry—about 50 miles long, 2 to 5 miles wide, 600 to 1000 ft deep and 600 ft above the level of the river at the site of Grand Coulee Dam.

Irrigation

The silted area is fertile land, with a long growing season, but lacks sufficient rain to support agriculture. The Grand Coulee Dam project is intended to change all this. A dam is to be built across Grand Coulee, as shown on the map, to create a storage reservoir into which water is to be pumped from the Columbia River. From this reservoir, irrigation water will be led by two canals, indicated on the map as the Main West Canal and Main East Canal.

To make this possible, the largest dam ever conceived by man is being built across the Columbia River near the upper end of Grand Coulee. It is of massive concrete construction, straight gravity type, 4500 ft long. Getting down to bedrock required excavation of 15,000,000 cu yd of overburden and 850,000 cu yd of rock. This volume of material would cover a square mile 16 ft deep.

The dam, Fig. 2, will be 553 ft high from the lowest point of its foundation and 500 ft thick at the base, tapering to 30 ft wide at the top, which will carry a roadway. The dam alone will have 10,200,000 cu yd of concrete in it. Power houses and other works will increase this figure to 11,250,000 cu yd. A spillway section 1650 ft long, designed to pass a 1,000,000 sec-ft flood with an effective head of 30.5 ft on the crest, is at the center of the dam. The spillway will consist of eleven 135-ft openings controlled by structural-steel drum gates 28 ft high. Each of these gates complete with control mechanism will weigh approximately 1,500,000 lb. Outlet works in the spillway section comprise 30 pairs of 8.5 ft conduits arranged in groups of 10 pairs at each of three elevations, differing in elevation by 100 ft. The dam will create a reservoir 150 mi long, backing water to the Canadian border, and will provide a maximum storage of 9,645,000 acre-ft and maximum head of 360 ft. A useful storage of 5,200,000 acre-ft will be available with 80 ft drawdown.

Power House

Adjacent to each end of the spillway section on the down-stream face of the dam will be a power house designed for nine main generating units. In addition, the west power house will have three 14,000-hp service units. Each main turbine, rated 150,000 hp under 335-ft head, will connect to a 120-rpm, 105,000-kw generator. These units have 18-ft penstocks and will be placed on 65-ft centers. Turbine and generator together will weigh over 3,500,000 lb, and will require two 375-ton cranes with an 80-ft span to handle the heaviest parts. A shaft 42 in. in diameter will connect each generator and turbine. With the three service units, there will be a total ultimate installed capacity of 2,742,000 hp, which is 900,000 hp more than planned for Boulder Dam. The initial power installation at Grand Coulee will comprise three 150,000-hp main units and two 14,000-hp service units. The service units will supply all auxiliary

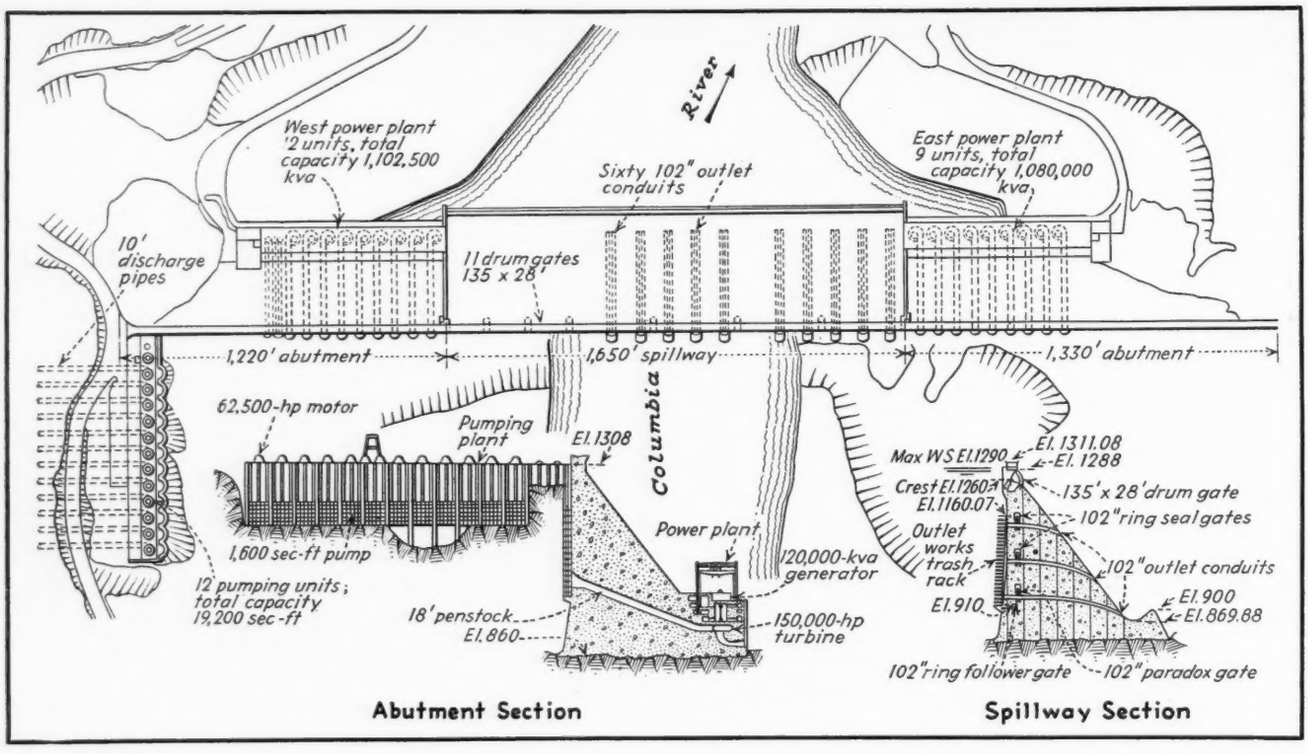


Fig. 2—Plan view of Grand Coulee Dam, power house and pumping plant, with cross sections through dam and power house

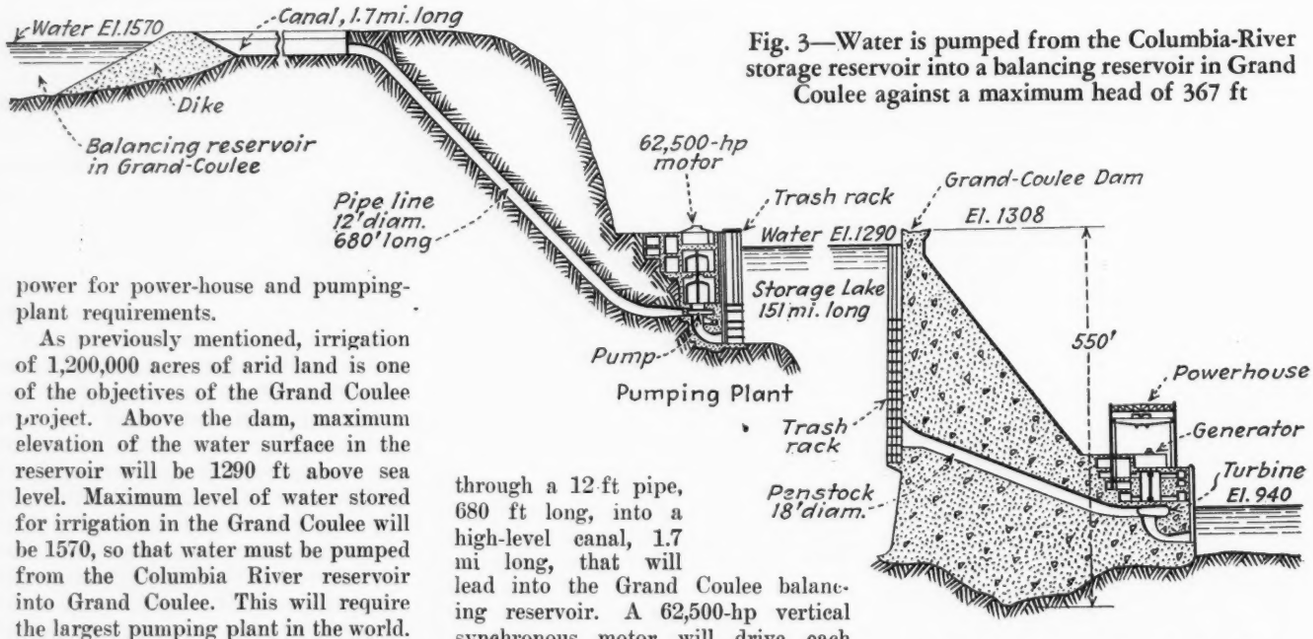


Fig. 3—Water is pumped from the Columbia-River storage reservoir into a balancing reservoir in Grand Coulee against a maximum head of 367 ft

power for power-house and pumping-plant requirements.

As previously mentioned, irrigation of 1,200,000 acres of arid land is one of the objectives of the Grand Coulee project. Above the dam, maximum elevation of the water surface in the reservoir will be 1290 ft above sea level. Maximum level of water stored for irrigation in the Grand Coulee will be 1570, so that water must be pumped from the Columbia River reservoir into Grand Coulee. This will require the largest pumping plant in the world.

Pumping Plant

Near its west abutment, Grand Coulee Dam makes a right-angle turn up stream. This section of the dam will contain the pumping plant—12 motor-driven vertical centrifugal pumps, each having a capacity of 1600 sec-ft (about 1,000,000,000 gpd) when pumping against a head of 295 ft. This head will occur when the reservoir elevation is at 1280, maximum head of 367 ft when reservoir level is 1208. Throat diameter of the pumps will be 12 ft and each will discharge through a 12-ft pipe, 680 ft long, into a high-level canal, 1.7 mi long, that will lead into the Grand Coulee balancing reservoir. A 62,500-hp vertical synchronous motor will drive each pump, giving the pumping plant a total capacity of 750,000 hp. Six generators in the power house adjacent to the pumping plant will supply power to the pump motors.

Work was started on the project in December 1933 and has been carried forward actively ever since. The first contract on the dam was completed last year and a second contract has been let for its completion in 1942. All work is under the direction of the U. S. Bureau of Reclamation. The dam and power houses are estimated to cost $179,000,000. Irrigation cost, including the pumping plant, will be $198,000,000, making a total expense of $377,000,000, which is expected to be repaid, half from sale of power and half by settlers on the irrigated land. When the power plants are completed, it is estimated that they will produce 8,100,000,000 kwhr of firm power and 5,000,000,000 kwhr of secondary power. Of the latter, 2,260,000,000 kwhr may be used for pumping during an irrigation season. High water and irrigation demands coincide so that no primary power will be required for pumping.

Plain Talk on Embrittlement

Chemist Fellows conspires with Editor Swain to make chemical facts understandable. Swain asks what the shootin's all about. Fellows answers without technicalities or pussyfooting—and his answers vitally concern every boiler operator

Interviewing C H FELLOWS
The Detroit Edison Co

WHEN we were talking the other day, Mr. Fellows, we agreed that the average power engineer finds it hard to keep up to date on embrittlement and that this may be 50% the chemists' fault, because all their articles are written in chemical jargon. Most power engineers are interested in chemistry only as a mother with a sick baby is interested in medicine. The boiler or the baby, as the case may be, has a "stomach ache", and the fond parent wants a cure, not a philosophical dissertation. To use castor oil or not to use castor oil, that is the question.

Boiler operators have worried a lot about "embrittlement". Every now and then some operator spots a hair-line crack in a seam. He takes the boiler off the line in a hurry and tests it by hammering the seam gingerly. Rivet heads pop off and he thanks his stars he noticed the crack in time. This sort of thing doesn't happen very often, but the fear that it may happen is not conducive to sound sleep.

Thousands of dollars have been spent in an attempt to find the cause and cure of embrittlement. Tens of thousands of words have been published on the subject. So what? Even today the average operator isn't sure what causes embrittlement or what he ought to do about it in his own plant. What's the trouble? Don't the chemists know, or is there something wrong with our system of transmitting research facts to the men who could use them?

The average power engineer is under the impression that embrittlement is caused by caustic soda, or something like that, in the boiler water and that it won't happen to him if he maintains the sulphate-carbonate ratios recommended by the ASME. Certainly that can't be a fair statement of what he *ought* to know. If it is, why is all this research still going on?

Let me ask you a few questions, so I can pass your answers along to *Power* readers.

First, suppose you tell me what started all this excitement about embrittlement.

Fellows—Fair enough! About 20 or 25 years ago, boiler operators all over the country began reporting a peculiar type of inter-crystalline cracking—hair-line cracks meandering between the crystals of the boiler metal. These cracks were never found except near joints or rivet holes, in rivets or at points where tubes were rolled into the drums. This probably meant the metal was highly stressed where the crack occurred.

The operators naturally blamed this headache on poor boiler construction and the manufacturers, in turn, on operating conditions. It couldn't stop there, so the manufacturers cooperated with the operators to survey all of the conditions surrounding boiler operation to see if they couldn't pin the trouble down to some specific cause or causes. Soon they had the answer —or thought they had—in the discovery of what appeared to be a relation between embrittlement and natural waters used as boiler feed in which there was a large proportion of natural alkalies.

This discovery soon developed into a relationship between embrittlement and the relative amounts of these alkali salts, principally sodium hydroxide, commonly called "caustic" or "caustic soda", and the salt, sodium sulphate, a sodium salt of sulphuric acid, in the boiler water. In this pioneer survey no case of embrittlement was found in plants where ratio of sodium sulphate to total alkalinity expressed as sodium carbonate in boiler water was kept constantly above certain levels.

This interesting discovery naturally suggested trying it out in the laboratory under controlled conditions, so the late Professor Parr and Professor Straub went to work at the University of Illinois. Using "bombs" of special design, they put steel specimens under tension in hot baths of caustic soda dissolved in water. They varied concentration (amount of caustic in solution) and temperature to see what concentrations would cause cracks at various water temperatures.

The "facts" discovered by the professors in the laboratory closely checked the field statistics of the boiler manufacturers. In the laboratory, as in the field, embrittlement did not occur when certain "sulphate-carbonate" ratios were maintained.

Swain—Just what do you mean by this sulphate-carbonate ratio?

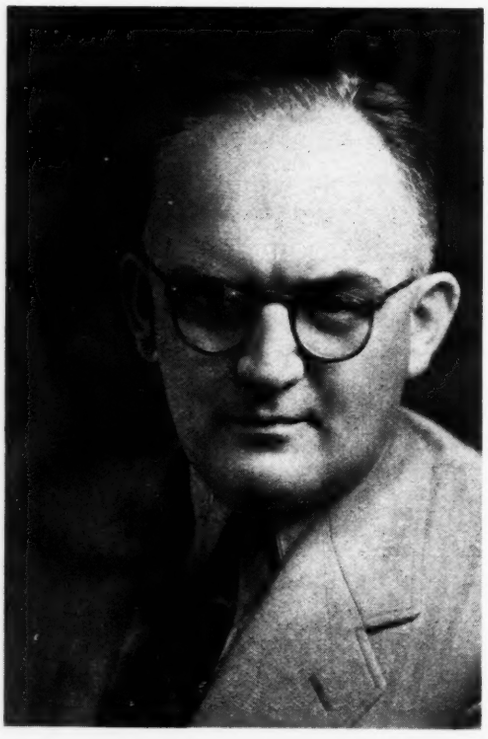
Fellows—The ratio is simply a fraction. Its numerator is the amount of sulphate assumed to be in combination with sodium as sodium sulphate present in a given sample of boiler water. Its denominator is the amount of hydroxide or alkalinity expressed in terms of its sodium carbonate (soda ash) equivalent.

What do you mean by the "sodium-carbonate equivalent?"

I mean the actual amount of carbonate ion assumed to be combined as sodium carbonate, plus the additional sodium carbonate that would be formed if all of the sodium hydroxide were changed into sodium carbonate. This is a common way that water chemists have of expressing total alkalinity.

The ASME Boiler Code Committee suggested different ratios for different pressures, didn't it?

Yes. On the basis of the field study and the laboratory work of Parr and Straub, the Committee suggested a ratio not less than 1 up to a boiler pressure of 150 lb gage. For pressures



C H FELLOWS

The chemist whose cooperation makes possible this straight-forward presentation of vital facts—is nationally known for his work in the field of power-plant chemistry, and is Chairman, Joint Research Committee, Boiler Feedwater Studies

from 150 to 250 lb they suggested a ratio of 2. For pressures above 250 lb the code suggested the use of a ratio of 3 as a reasonably sure way to stop this kind of cracking. (Engineers weren't thinking much about 1400 lb in those days. The ratio of 3 certainly wouldn't protect at that pressure. In fact, if you used enough more sodium sulphate to prevent embrittlement at 1400-lb pressure you'd probably have a lot of trouble with carryover.)

Mr. Fellows, don't you think these ratios settle the whole matter, except of course, for high pressures? If they were safe ten years ago they ought to be safe today. Isn't it true that if a boiler operator will maintain the ASME ratios he will have no trouble with embrittlement and therefore not need to bother his head about the matter further?

Mr. Swain, that's where you bring me right back to your question, "Why is all this research still going on?" The simple fact is that the ASME Code ratios are far from being the final solution. When they were first issued the users of steam-generating equipment accepted them with enthusiasm. Improvement was evident. In some cases, however, operators claimed to have encountered embrittlement even where they had followed, or perhaps I should say, tried to follow, the ASME suggestions. In other cases operators began to grumble, "Why should we go to all the trouble and cost of maintaining this ratio, when our own records show that we operated without it for years and never had any embrittlement?"

Do you mean to say, Mr. Fellows, that maintaining the ASME ratio does not necessarily protect a boiler from embrittlement?

What I mean to say is that the *apparent* maintenance of the ASME ratios by some of the complaining operators didn't seem to do them any good.

Your wording suggests that the operators were fooling themselves—that they weren't really maintaining the ratios, merely thought they were.

I suspect that's true. In some cases, at least, we know from a study of the original records that operators who claimed to have maintained the ratio steadily, and who honestly believed that they had, did at times allow it to fall below the specified limits.

If that were all the evidence, we might still assume that the ASME ratios are the last word. Unfortunately, as Robert Burns has pointed out, "The best laid plans of mice and men gang aft agley." New and disturbing facts were unearthed. In general, sulphate seemed to do the trick with stationary boilers, but it wouldn't work with locomotives.

The story is interesting. In many parts of the country the embrittlement of locomotive boilers had long been a serious problem. Naturally then, when the ASME ratios were first published, they were eagerly accepted as the panacea for embrittlement. Bitter disappointment followed. Ratios or no ratios, cracking continued, even with new locomotives in all districts where locomotive boilers had the habit of embrittling before the ratios were adopted. Not a single clearly proved case has come to light where maintaining the ASME ratio has afforded real protection to a locomotive boiler. Almost equally disconcerting was the discovery that locomotives in certain districts had been operated for years without maintaining ASME ratios, and without any trouble from cracking. Evidently the chemical composition of the water wasn't the only factor in the cause and cure of embrittlement in such boilers.

About this time it became evident to R E Hall and other consulting chemists that we'd have to learn more about the solubility of sodium sulphate at various temperatures, particularly at the water temperatures found in high-pressure boilers if economical treatment to prevent embrittlement on this basis were to be followed.

Why bother about the solubility of sodium sulphate? Won't it dissolve in far greater quantities than are ever found in a boiler drum?

That's true, but we really don't care particularly how much sodium sulphate can dissolve in boiler water. There has never been a case, in a laboratory test, where embrittlement has been produced by any salt found in the mass of the boiler water at any concentration existing in regular operation.

You mean to imply, then, that water composition alone is not the thing that causes embrittlement; that concentration and perhaps other factors are necessary?

Right; embrittlement will not occur except where water of the right composition, at the right boiler pressure, concentrated far beyond anything possible in the drum itself or in the tubes, comes in direct contact with highly stressed metal. That is why cracking never occurs in the body of the plate, only in the seams, or in and around rivets or tube ends. In such places the solution can be so concentrated by

leakage and evaporation that any salt, however soluble, will settle out. It has been thought that the amount of sulphate in the water has to be so proportioned to the amount of hydroxide as to permit the sulphate to "beat the gun" by settling out and forming a protective layer of salt before the sodium hydroxide in solution becomes concentrated enough to dissolve the cementing material around the individual crystals of metal.

In the laboratory tests, how concentrated does the sodium hydroxide have to be to start intercrystalline corrosion?

Between 50,000 and 500,000 parts per million (about 3000 and 30,000 grains per gallon).

What is the most you find in boiler water?

I should say about 1000 parts per million, as a maximum, which shows why the embrittlement never occurs except in seams or around rivets and tube ends where the water can concentrate.

I suppose this means that welded boiler drums never show embrittlement except around the tube ends.

That's right, and there have been very few cases of embrittlement of welded drums even around the tube ends, probably because of excellent fabrication and assembly.

Getting back to the point, did those solubility experiments bring out any facts of interest to the average power man?

Yes, but not what you'd expect. The idea, of course, was to find out *how little* sodium sulphate would protect a boiler. No sense putting in more sulphate than is needed to start precipitation before the hydroxide attack begins.

This solubility research was carried on by a subcommittee of the Joint Research Committee on Boiler Feedwater Studies. The experimenters found what they set out to find (the solubility of sodium sulphate) and then, as sometimes happens, ran headlong into another string of knotty problems.

What do you mean?

As I just said, the purpose of the solubility experiment was to find a way to economize sulphate—how to use just enough and no more. Having figured out from solubility data how much sulphate *should* be necessary, the next move was to "try it on the dog."

The first step, I suppose, was to embrittle specimens with sodium hydroxide and then try to stop it by adding the calculated amount of sulphate.

Yes, but let me tell you something funny: The researchers started out to crack steel tension specimens in bombs, using solutions of sodium hydroxide. Unfortunately, the specimens didn't need any cure because the hydroxide wouldn't crack them. Another first-class mystery! You don't read such stories in the textbooks, but they happen in real life.

I thought they had proved already that sodium hydroxide would embrittle steel.

So did everybody else up to that moment. It was a terrible shock, but there was nothing to do but go back to the original investigations and see how anybody else had been able to crack steel with sodium hydroxide. The astounding discovery was made that the sodium hydroxide which had embrittled steel in the earlier tests had actually contained small quantities of impurities whereas that used in the later test was practically chemically pure and that the presence of such impurities radically changed it. The bad actor was found to be silica, an element found in sand—not much silica,

A photomicrograph of a caustic embrittlement crack—this one from an operating boiler

but a lot too much—enough to upset the universal belief that sodium hydroxide alone would cause cracking.

In short, the difference between black and white?

Well, just about. To sum up, we know that pure sodium hydroxide will embrittle steel at temperatures up to about 300 F and not above, but that sodium hydroxide *plus* silica will *not* embrittle in this low-temperature range. The reason for this is thought to be the fact that the pure hydroxide is not active enough in this temperature range to dissolve the entire metal surface, but can dissolve the grain boundaries.

Now when silica is present it forms a protective film which the hydroxide cannot break through at these temperatures. On the other hand, at temperatures around 490 F the hydroxide *plus* silica *will* embrittle and hydroxide alone *will not*—just the reverse, and this is due to the fact that at this higher temperature sodium hydroxide breaks through the protective film at a vulnerable point—the boundaries of the crystals, and when no silica is present the pure hydroxide tends to dissolve all of the metal uniformly, not just the crystal boundary material.

Sounds like a Chinese puzzle to me.

No doubt about that. These confusing experimental results convinced us that we would never get very far with these studies until we learned just what causes embrittlement. Fortunately, the facts pointed to a likely explanation, as follows: It was practically certain that embrittlement involves some kind of corrosion. This, clearly, was not uniform corrosion of the metal surfaces as a whole, but rather an accelerated attack of the binding or cementing materials between the metallic grains. It seemed to follow that any substance or manipulation which would create and maintain a protective film over the metal, and *particularly over the grain boundaries,* would retard embrittlement. So the chemists are now hard at work trying to find what substances, under what conditions, will form a protective film, particularly over the grain boundaries.

Mr Fellows, this is all very interesting, but I'm still confused on a mighty important practical point. In the light of today's knowledge, what would you recommend as a safe operating procedure for the man who runs boilers and isn't interested in chemistry, except to keep out of trouble? Would you, or would you not, tell him to stick to the ASME ratios until the chemists have something better to offer?

I think I can give you a reasonable answer, but it will take some explain-

(*Continued on page* 100)

Power Philanthropy

New York Post-Graduate Hospital's Engineering Dept, by plugging away at improving power-plant and building operation, has saved over half a million dollars in 14 years—and savings are as good as contributions

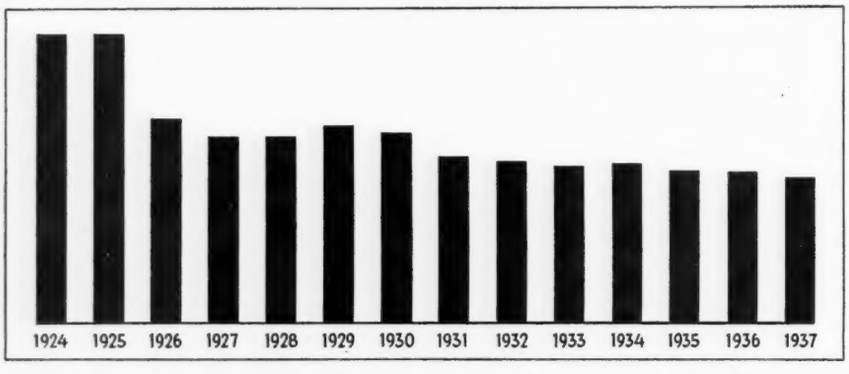
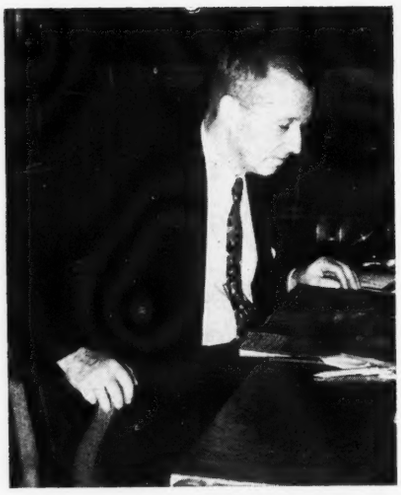


Chart shows how coal burned per year per 1000 cu ft of building space decreased with improvements in equipment and operation



Born in the little town of Mold, Norway, Lorentz Westvig was educated for engineering at Throndhjem. After the usual shop apprenticeship, he entered marine service, reaching Chief's rating at 27. In 20 years at sea he served in Norwegian, British, and American ships, saw nearly all corners of the world, and learned power-plant operation in the toughest of all schools. Position as power chief at Post-Graduate was Mr. Westvig's first shore job and he's been with it since 1924. Now in charge of all engineering, construction and maintenance at the hospital, he makes his job his hobby

POWER ENGINEERS aren't often listed among our major philanthropists—not for lack of big hearts but for lack of pocketbooks of the necessary size. So Lorentz Westvig, Chief Engineer of the New York Post-Graduate Hospital, gets a real kick out of figuring that, by saving more than half a million dollars in operating costs in 14 years, the Engineering Department is really one of the institution's largest contributors. The story of those years is one of constant effort to meet growing loads and to cut expense by improvements in equipment and operating methods.

Back in 1924, the plant consisted of three handfired boilers with a total heating surface of about 5000 sq ft, and two small slide-valve engines. Engine exhaust was used for building heating. Operating costs were high because of deferred maintenance, so the first step in a program of betterment was to thoroughly overhaul existing equipment. After immediate problems of this kind had been licked, there was time to take a deep breath and decide what major improvements should come first.

Buying overfeed stokers and installing new baffle walls increased boiler output and released firemen for more productive work. The remainder of $20,000 secured from the directors for power-plant improvements went for a 250-kw unaflow-engine-generator set to bolster electric output. Scouting the market thoroughly uncovered a real bargain, as it was found possible to buy a unit from a downtown office building where private generation of power was being abandoned. The effect of boiler changes, stokers, and the engine-generator can be clearly seen in Fig. 1, where fuel consumption takes a nosedive in 1926, the year these changes were effective.

Actually the facts are more dramatic than the chart. Not having accurate records of steam or power generation over this period, cu ft of building space has been taken as an approximate measure of load. Thus the chart shows how tons of coal per year per 1000 cu ft of building space decreased steadily as equipment and operating methods improved. The picture becomes even better when allowance is made for the undoubted increase in steam and power use per unit of building space, due to better lighting and higher service standards. Some idea of load growth can be gained from the fact that a survey made by the local utility in 1923 showed a yearly consumption of about 450,000 kwhr, while 801,000 kwhr were generated last year. This increase of 75% in electric load compares with a 13% increase in building volume over the same period. And over the same period, coal burned dropped from 7100 tons per year to 4006 tons.

Heating-System Overhaul

At the time the power plant was being put on its feet (1925), about half a million cu ft of building space was added to the hospital but wasn't connected to the power plant because it just couldn't take it. Changing the old gravity heating system to a vacuum installation did the trick; savings in steam were enough to permit tying

the new building load to the system. Equally important in producing steam savings was the thorough overhaul that went with the changeover. Every foot of the heating system was checked for weak spots and drainage was improved.

The wolf was at the door again in 1930—50,000 cu ft were added to the hospital in 1929, and again it was up to the Engineering Department to figure a way of supplying it without adding capacity in the plant. The answer seemed to be in the steam supply to the Nurses' Home, across the street from the main building. This supply was live steam; changing to exhaust would mean a real saving and release needed steam generating capacity. A new franchise was secured and a 5-in. line run across under the street. The investment of $1300 returned $400 a month on the first season's operation.

Typical of smaller changes which stepped up plant efficiency was a series of improvements in the laundry, a big steam and hot water user. Flushing-water connections were switched from house-service piping direct to street mains, which eliminated loss of pressure on the house lines every time laundry flush valves were opened. A separate water heater for the laundry furnished water at higher temperature so operators no longer needed to shoot in live steam to jack up washer temperature. This saved live steam, of course, but also saved 4% in makeup requirements, since steam used in the washers was lost. Attention to details of this kind has brought makeup down to about 10-12% during winter months, an excellent record when it is realized that some steam uses have no returns, or return contaminated water.

By 1935, it was evident that new boilers were necessary, and thought was given to their selection. Keeler "CP" units were finally chosen and in 1937, 1—3000-sq-ft and 2—2000-sq-ft steam generators, equipped with Riley-Jones side-dump stokers, were installed. As shown in the cross section, these boilers require no setting in the conventional sense of the word, the only brickwork being in the frontwall and bridgewall. Both sidewalls are water cooled and backed with refractory tile and blanket insulation. The entire unit is steel encased and supported on a structural steel frame. Although units up to 2500 sq ft can be shipped completely assembled it was impossible to take advantage of this feature at Post-Graduate, since the plant is located in the basement of the hospital, without ready access.

Control Equipment

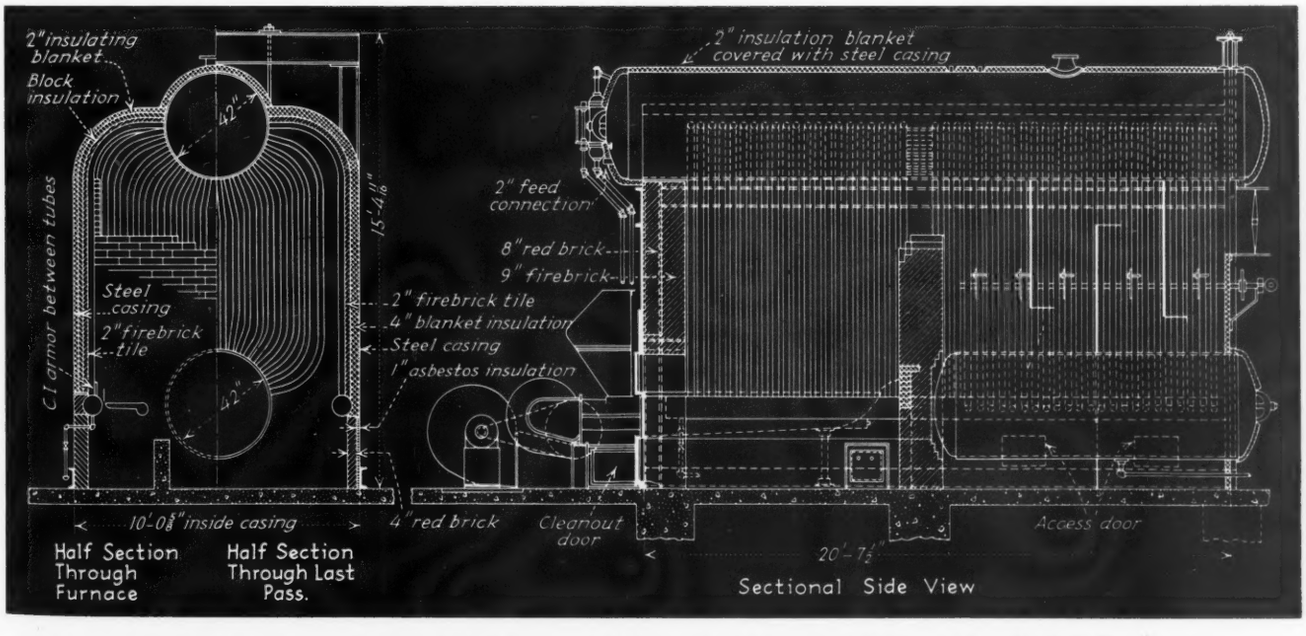
With the new boilers came much needed instruments, including draft gages, flowmeters, and an exit-gas temperature recorder. Control of combustion is effected by a Cash outlet-damper controller on each boiler and a single Cash control unit to regulate stoker operation. Stokers are driven by a constant-speed motor, with integral fans. Rate of coal feed is controlled by changing the interval between strokes of the feed ram; the steam-pressure-actuated controller automatically adjusts a timing mechanism on the mechanical drive. The controller also regulates a vortex damper on the fan, giving varying air flows with constant fan speed.

Operation of the new equipment has been highly satisfactory. Fuel is a free-burning Pennsylvania bituminous (2-in. nut and slack) of the following analysis:

Moisture	0% to 2%
Volatile	17% to 19%
Fixed Carbon ...	72% to 74%
Sulphur	under 1.25%
Btu, dry	14,250 to 14,500
Fusion Temperature	2800 F

As determined by a running measurement of coal consumed, and flowmeter records of steam output, evaporation is better than 11 lb of steam per lb of coal, and efficiency runs around 83.84%. These figures represent average operating conditions. Frequent analyses of flue gas by Orsat indicate an average CO_2 of 16% without perceptible CO. Stack temperatures run slightly under 500 F.

Along with improvements in plant and equipment, better operating procedures have had their share in pulling power costs down. Typical are the results obtained by carefully selecting coal instead of just buying it. Originally coal was purchased in small quantities from the yard, with no attention to analysis. First step was to enlarge the bunker so coal could be bought in larger quantities, direct from the mine. Experimenting with coals of various analyses has shown what characteristics are desirable, and so it is possible to specify the kind of coal wanted, by analysis. Lacking facilities for fuel testing, the coal company's average analysis is accepted, subject to the check of performance. Intimate knowledge of the way boilers and stokers should perform enables operators to spot coal that causes inferior performance.



Sections show water-cooled furnace and drum arrangement of new stoker-fired boilers

Installing Single-Retort Stokers

Good results depend on fitting stoker to load requirements, and setting it properly in furnace—here are some pointers on both. Third of a series on modern stokers

By L N ROWLEY
Assistant Editor

PRECEDING ARTICLES have described single-retort stokers of both screw-feed and ram-feed types. Assuming that a single-retort stoker seems to suit a given plant, what points should be considered in making the installation? This article discusses the most important factors, with particular reference to screw-feed units. While general principles involved apply equally to ram-feed stokers, specific data on installation of these will be given in the next article.

What Size Stoker?

First question is usually "what size stoker?" A simple question but full of pitfalls for the unwary. Basically the job is to match boiler load and stoker rating. Let's look at boiler load first. If load is heating, it will be fairly constant during operating periods, varying with outside temperature. Best way to estimate heating load is to calculate heat loss from building under worst possible weather conditions—this will give peak condition. When modernizing an existing plant, heating load can be figured by adding up the area of all direct radiation, and then adding about one-third to allow for radiation from pipes and for the extra push needed to pick up a cold building. Multiplying area of radiation in sq ft by 240 (steam) or 150 (water) gives heating load in Btu per hr. Don't base boiler load on connected radiation if experience shows the existing heating system can't keep the building warm. Start from scratch and figure building heat loss, adding needed radiation to system.

If the stoker is to go under a power boiler, nature of load counts for a lot. Power or process loads are likely to swing heavily, and the firing equipment must be big enough to take the swings. Don't choose a stoker on the basis of the horsepower rating of the boiler. Horsepower is at best a poor measure of boiler capacity, and meaningless if boilers are operated above rating, as is often the case. Obviously a stoker just big enough to carry rating won't do when overload is necessary.

Best bet is to estimate peak steam load. If plant is new, it will have to be figured from estimates of equipment steam consumption. In old plants, steam- or water-meter records may give data needed, but in most cases, instruments aren't available. A rough and ready answer can be had by weighing coal burned during the hour of heaviest output. This will give the required burning rate of the stoker directly.

Heating Value

Let's say we've got the peak load, whether heating or power, and we've got it in Btu per hr (load in lb of steam can be converted to Btu by finding heat content of steam from Mollier chart or steam tables). Now we need to know how many heat units we can get from our coal. Trustworthy coal dealers will give average heating value of coal of the type burned, or a sample can be sent to a laboratory for testing. Remember, it's the heating value of the coal "as fired" (with its moisture) that's wanted, not the heating value "dry." Be sure to make allowances if coal of lower quality is likely to be burned at some later date. If so, it is safest to figure on the lowest heating value likely to be met.

Dividing load in Btu per hr by the Btu of the coal would give the amount of coal the stoker must burn in an hour, if boiler and stoker were 100% efficient. But they're not, so it's necessary to multiply by expected efficiency. The Stoker Manufacturer's Association has agreed that 65% for burning rates up to 100 lb per hr and 70% for higher rates are reasonable over-all efficiencies.

The result of all this figuring is the amount of coal the stoker must be capable of burning in one hour. Nearly all manufacturers of stokers rate them in lb of coal per hr so we're within striking distance of an answer. First be sure that the rating given refers to coal-burning capacity and not merely coal-feeding capacity. Then be sure that no load increase is expected in the future, which would make a larger stoker desirable. Finally, allow a little slack in matching boiler load and stoker rating. If load is within 20% of maximum stoker rating, it's best to take the next larger size—the reserve capacity will pay in the long run.

Emphasis on peak load doesn't mean that it's the only consideration. Where there is a wide spread between maximum and minimum loads, the ability of the stoker to feed coal slowly must be considered. If it can't feed slowly enough, the controls will shut it off for long periods, which makes for unsatisfactory combustion conditions. If possible, the unit should run 65-75% of the time, during the operating period.

Combustion Volume

Adequate combustion volume and setting height are of prime importance in designing a stoker installation, particularly when modernizing an old boiler. Insufficient volume means incomplete combustion and that means losing the efficiency and smokelessness that the stoker ought to have. If setting is too low, partly burned gas strikes boiler surfaces and is chilled, stopping combustion before completion. Direct flame impingement results in overheated and burned boiler surfaces.

How much combustion volume is needed? Manufacturers recommend a maximum heat release in the furnace of from 40,000 to 60,000 Btu per cu ft, with the majority suggesting 50,000 as the upper limit. What does this mean in terms of furnace size? Take the peak load figured before (in Btu per hr), and divide it by 50,000—the result is volume in cu ft. Remember this is minimum volume—more ample dimensions mean better combustion and give a reserve for load growth or

emergency conditions. In setting stokers under hrt boilers, some of the space behind the bridge wall can be counted as combustion space; about ⅓ of it according to some engineers.

Minimum setting height (measured from top of retort to lowest part of boiler surface) runs from 2½ to 3 ft on units with 100-lb-per-hr coal-burning rate, to about 5 ft for 1000-lb per-hr or larger units. The best setting height depends on many factors, such as kind and grade of coal, thickness of fuel bed, rate of fuel feed, draft, etc, but most manufacturers specify both minimum and desired heights for their equipment.

Check Draft Facilities

Because nearly all small stoker units have integral forced-draft fans, the buyer often neglects to check existing draft facilities. Remember that the fan only takes the air through the fire bed —the stack still has to pull the air through boiler and breeching. Draft required varies with type of boiler and condition of gas passages and also with amount and arrangement of breeching. For normal conditions, a stack 15-20 in. in diameter and 50-60 ft high will serve a 100-lb-per-hr stoker while a 42-48 in. stack, 80-90 ft high will serve 1000-lb-per-hr and larger units.

Actual setting arrangements vary too much to be described in any detail here. Several typical arrangements are illustrated, and the following check list gives some points to be considered:

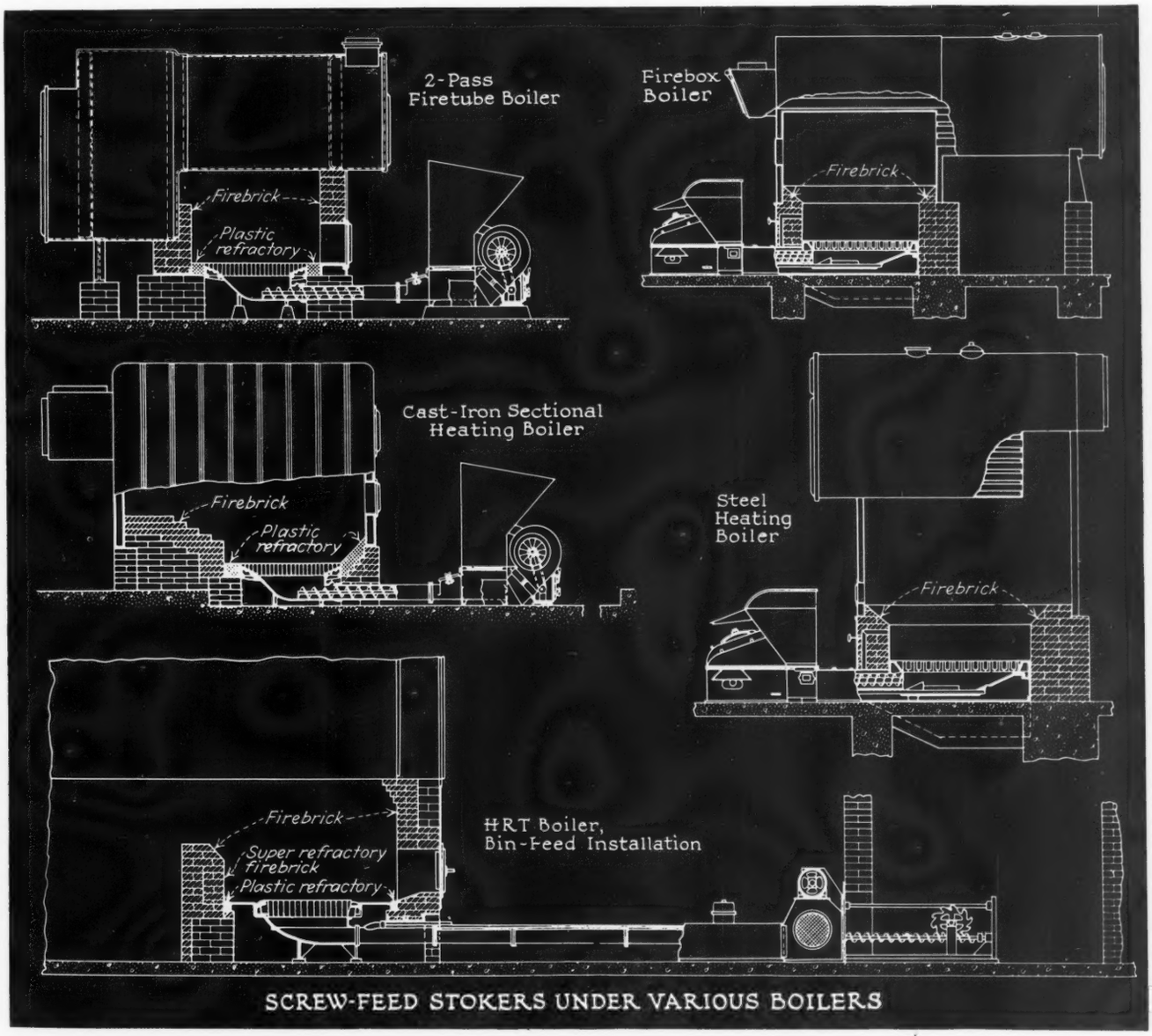
Coal and Ash Handling—Keep in mind possibility of improved coal handling either by chute or downspout from overhead bin, by screw feed from floor-level bin, or by overhead trolley. Arrange setting and locate ash doors for easy removal of ash and clinker.

Pitting—Where necessary to place stoker in a pit to get required furnace volume or setting height, check for obstructions under the floor before digging the pit, and also find out if water line is above pit floor. Be sure space is available for feed screw removal and for access to drive mechanism. Pit sides shouldn't be so close to fan intake as to restrict air flow. Sometimes the fuel bed is below the water legs of cast iron or steel boilers; if so, protection with refractory is required.

Hrt Boilers—Check settings for leaks. It is often necessary to lower the bridgewall, which should only extend about 12-18 in. above the dead plates or dumping grates.

Cast-Iron Boilers—Check sections for cracks. Usually only necessary to remove grates and front ash pit plate.

Ordinances—Many cities have regulations covering design of settings, types of firing equipment, etc. Checking these before installation may save a lot of trouble later.



SCREW-FEED STOKERS UNDER VARIOUS BOILERS

Practical Pipe Hangers

Most pipe hangers are a combination of pipe clamp, beam clamp, and connecting rod. Here are construction dimensions and safe load values

By ALLEN M PERRY
M H Treadwell Co, New York, N. Y.

ON A RECENT construction job, several hundred pipe hangers had to suit a variety of conditions. Many different sizes and weights of pipe called for pipe hangers of several designs and load-carrying capacities. Time and expense in designing, fabricating and erecting were saved by adopting a set of standard clamps for pipe, beam and channel, modifying only the length of connecting rod to the distance of pipe from its support.

These standard hanger components can apply in the majority of cases. Special conditions, obstructions, no support directly above the pipe, or two or more pipes very close together, require additional parts and sometimes complicated hanger design. The exceptional instances only serve to emphasize the value of standardized parts wherever they can be applied.

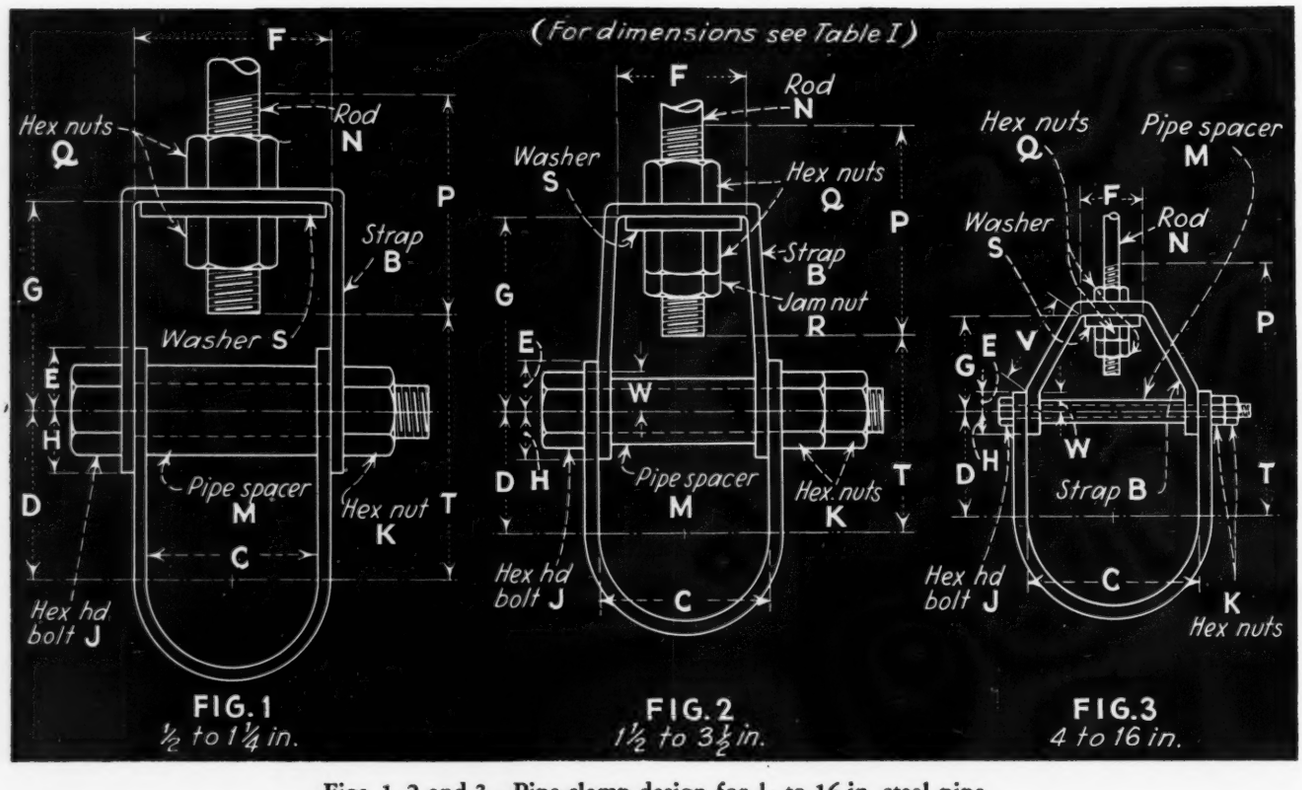
The accompanying illustrations and tables show designs of pipe, beam and channel clamps in sufficient detail to permit their construction from strap iron and other readily available materials. These elements can then be combined with springs, horizontal members and the like, which can also be standardized to a certain extent.

Preparing drawings for hanger fabrication is also greatly simplified by use of translucent forms schematically indicating the design but with blanks for dimensions. Only the major variable dimensions need be filled in; reference to the tables shown here supplies details for the standard parts.

Selection and design of hangers is often left until the last minute because of the difficulty in visualizing obstructions in the initial design stages, or because alterations have to be made in the field. With some degree of standardization and a sheaf of schematic drawings, field engineers can record available supporting members, hanger components necessary and major dimensions. No drawing has to be prepared other than these sketches as the details are standard.

The tables also simplify preparation of material lists and cutting. Duplicates of the filled in form, by blueprinting or some other process, are simple for the fabricator to follow and tend to avoid misinterpretation which accompanies special designs. This represents a considerable advantage when hangers are made in the field.

Table I gives dimensions for the designs of Figs. 1, 2 and 3. Where



Figs. 1, 2 and 3—Pipe-clamp design for ½- to 16-in. steel pipe

TABLE I — PIPE CLAMP DIMENSIONS FOR ½ - TO 16-IN. STEEL PIPE

Sketch	Pipe dia.	Max. load† for clamp	Straps and Dimensions										Bolt and No. of nuts		Pipe spacer	Rod, thread length, No. of nuts				Washer	
			A*	B*	C	D	E	F	G	H	V	W	J	K	M	N	P	Q	R	S	T
Fig. 1	½	200	⅛x1½x5⅛	⅛x1½x6⅛	⅞	1⅛	⅝	1⅛	1¾	⅝	—	—	⅜x2	1	⅜x ¾	⅜	2½	2	0	0	2
	¾	200	x5⅞	x6⅞	1⅛	1¼		1⅜	2		—	—	x2¼		x1						2¼
	1	1000	x2 x6⅜	2x7⅞	1⅜	1⅜		1⅝	2⅜		—	—	x2½		x1¼		2⅞			5/16x1½x2	2⅜
Fig. 2	1¼		x7¼	x8¼	1¾	1½		2			—	—	x3		x1⅝					⅜x1⅞x2	2½
	1½		⅜x2 x7⅛	⅜x2 x7⅛	2	1⅜	½	1 9/16	2⅛	½	—	⅜	x3½	2			2⅜		1	5/16x1⅜x2	2⅜
	2	1200	¼x2 x9⅛	¼x2 x10⅛	2⅜	1 11/16	¾	2⅛	3	¾	—	—	¼x4		½x2	½	3¼			⅜x2 x2	3
Fig. 2	2½		x10⅛	x10⅝	2⅞	1 15/16		2⅝			—	—	½x4½		x2½					x2½	3⅜
	3		x12	x12¾	3½	2¼	⅞	3¼	3½	⅞	—	—	x5		x3½		3⅞			½x2 x3	3⅞
	3½	2300	3/16x2½x13⅝	3/16x2½x13⅜	4	2⅝			3 13/16		—	9/16	⅝x6		¾x3½	⅝	4¼				4¼
Fig. 3	4		x14⅞	x12⅛	4½	2⅞		2	4		3 7/16		x6½		x4			3	0	x1¾x1¾	4⅝
	5	2800	¼x2½x19⅛	¼x2½x15¼	5 9/16	3⅜	1⅛	2¼	4⅞	1⅛	4½	⅝	¾x8		x4 13/16	¾	5¼			x2 x2	5⅜
	6		x21¼	x15⅝	6⅝	4 1/16					4 11/16		x9		x5⅞						5¾
Fig. 3	8	5200	⅜x3 x27	⅜x3 x18¼	8⅝	5 3/16	1¼		5 11/16	1¼	5 11/16	11/16	⅞x11½		1x7⅝	⅞	6⅛			⅝x2 x2	7⅜
	10	4900	x32½	x21⅛	10¾	6¼			6½		6 13/16	¾	1x14		x9¾	1	7⅛			¾x2¼x2½	8½
	12		x38⅛	x23¾	12¾	7¼	1½		7⅛	1½	7⅞		x16		x11¾		7¾			⅞x2¼x2½	9¾
	14	5600	½x3 x42	½x3 x26⅝	14	8⅛		3¼	8⅜		8 13/16	⅞	1¼x18		1¼x12¾	1¼	9¼			1x3 x3	11
	16		x47½	x28⅝	16	9⅛			8⅞		9 13/16		x20		x14¾		9¾				12¼

† — *Apply factor of safety to allow for corrosion and stresses due to weaving of pipe with temperature changes.*

* — *Developed lengths of straps A and B are longer than actual finished straps to facilitate fabrication.*

Where a blank appears, use value immediately above.

no value is inserted, the preceding one applies. In a few cases where no dimension exists, a dash so indicates. The length of pipe straps *A* and dimension *D* can be increased ¼ and ⅛ in. respectively to give more clearance between pipe and spacer. This allows for variations in outside diameter of

TABLE II—I-BEAM CLAMP DIMENSIONS FOR ½ - TO 16-IN. STEEL PIPE

Pipe size	Beam clamp dimension A	B C D E	F	G	Bolt (with one nut and lock washer)	Pipe spacer J	Bolt (with two nuts) K	Rod and eye L	Rod and eye M	Max loading, lb†	Size and weight of I-beam in. lb.	Clamp dimensions B	C	D	E
½	⅜x2	SEE TABLE ON BEAM SIZE	⅝	1¼	¼x2	½x7/16	½x2½	⅜	⅝	200	6-12.5	3⅜	1	⅜	2¾
¾											7-15.3	3⅝			
1	½x2				x2¼		x2¾			1000	8-18.4	4			
1¼											-20.5	4⅛	1 1/16		
1½			¾		⅝x2½	¾x7/16	⅝x3		13/16		9-21.8	4⅜	1⅛		3
2						x9/16	x3¼	½			10-25.4	4⅝	1 3/16		
2½											-30	4⅞	1¼		
3	x2½			1⅜						1200	12-31.8	5		⅝	
3½					x2¾	x11/16		⅝			-35	5⅛			3½
4	x3			1½			¾x3¾		1	1400	-40.8	5¼	1 5/16		
5						x13/16		¾			15-42.9	5½	1⅜		
6											-60.	6	1½	¾	
8	⅝x3		⅞	1¾	¾x3½	x1	⅞x4½	⅞	1⅛	2000	18-54.7				3⅜
10	x4		1	2	⅞x3¾	1x1⅛	1x4¾	1	1¼	3000	20-65.4	6¼	1 9/16		3¼
12											-81.4	7	1¾		4
14	¾x4			2½	1x4½	x1⅜	1¼x5¾	1¼	1½	4500	24-79.9				
16															

† See Table I.

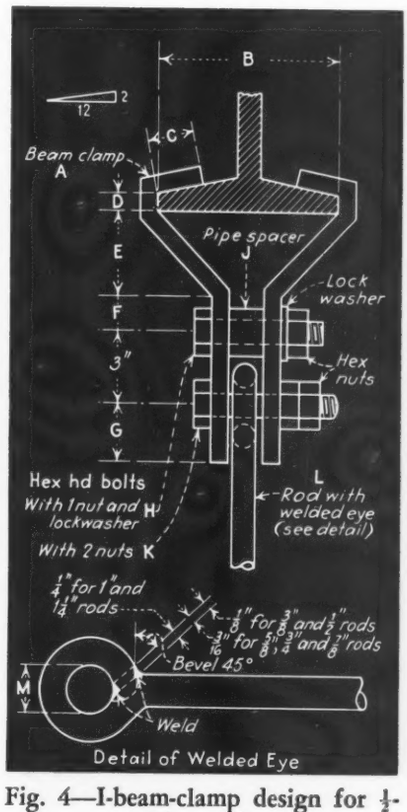


Fig. 4—I-beam-clamp design for ½- to 16-in. steel pipe

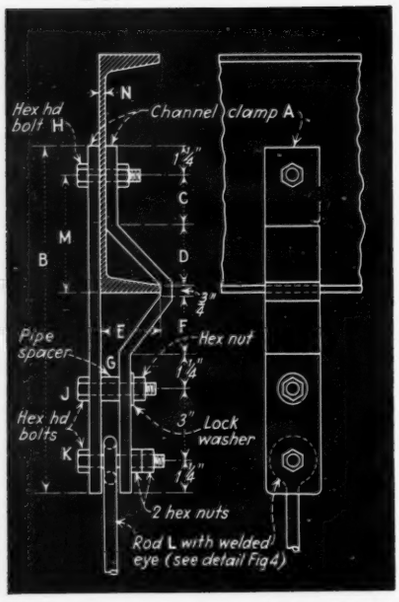


Fig. 5—Channel-clamp design for ½- to 3-in. steel pipe

TABLE III—CHANNEL CLAMP DIMENSIONS FOR ½- TO 3-IN. STEEL PIPE

Pipe size	Clamp dimensions A	B C D E F	Pipe spacer G	Bolts with one nut H	Bolts with washer, nut J	Bolts with two nuts K	Rod L	Max† loading	Size and weight of channel in. lb.	Clamp dimensions B	C	D	E	F	M	N
½	¼x2	See Table on Channels	½x7/16	½x2	½x1¾	½x2¼	⅜	200	6–10.5	13½	1	2	2	3	3	5/16
¾									7– 9.8	14	1⅜	2⅛	2⅛		3½	¼
1	⅜x2				x2	x2½		1000	8–11.5	14¼	1½	2¼	2¼		3¾	
1¼			¾x7/16	⅝x2	⅝x2¼	⅝x2¾	½		–13.75	14⅞		2⅜	2⅜	3½	3⅞	5/16
1½									9–13.4							¼
2			x9/16						10–15.3	15⅝		2⅝	2⅝		4⅛	
2½	x2½							1200	–20.0	15¾		2¾	2¾	4	4¼	⅜
3									12–20.7	16		3	3		4½	5/16
									– 25.							⅜
									15–33.9	16⅞		3⅜	3⅜	4½	4⅞	7/16
									–35.							
									18–42.7	17½		4	4		5½	
									–45.8							½

† See Table I.

pipe and inaccuracies in drilling.

Table II gives dimensions for beam clamps, the design for which is shown in Fig. 4. Channel clamp dimensions, Table III, cover only sizes up to 3-in. pipe but for channel sizes up to 18 in.

Table IV shows maximum permissible loading of the standard pipe and beam clamps for direct comparison with the unit weights of various classes of steel pipe. For pipe of 2-in. diameter and larger, it will be noted that maximum permissible loading of beam clamps in most cases is less than the corresponding pipe clamps. This permits a higher safety factor in the pipe clamps, usually subject to greater corrosion as well as expansion and contraction stresses.

Factors of safety are shown for standard beam clamps supporting 20 ft of plain pipe, exclusive of flanges, valves and cover. Greater spans can be carried with proportionate reduction in safety factor, but due allowance should be made for extra weight of fittings and cover and for temperature expansion. For small size pipe, it would be unwise to increase spans as much as maximum clamp loadings would seem to warrant, as pipe deflections increase above desirable values in long spans, thus increasing pipe stress.

These standard components are applicable to ready construction of a few hangers (avoiding design calculations) as well as to saving time and expense where a large number of hangers are involved.

TABLE IV — COMPARISON OF MAXIMUM PERMISSIBLE CLAMP LOADING AND UNIT WEIGHTS OF STEEL PIPE

Pipe size	Outside diameter	Maximum loading-lb.* Pipe clamp	Beam clamp	Channel clamp	250-lb Lap-welded lb/ft	250-lb Lap-welded Safety† factor	300-lb Seamless lb/ft	300-lb Seamless Safety† factor	400-lb Seamless lb/ft	400-lb Seamless Safety† factor	600-lb Seamless lb/ft	600-lb Seamless Safety† factor	1500-lb Seamless lb/ft	1500-lb Seamless Safety† factor
⅛	0.84	200	200	200	—	—	.86	11.6	.86	11.6	1.09	9.2	1.31	7.7
¼	1.05				—	—	1.14	8.8	1.14	8.8	1.48	6.8	1.94	5.2
1	1.315	1000	1000	1000	—	—	1.68	29.8	1.68	29.8	2.18	23.4	2.85	17.5
1¼	1.66				—	—	2.28	21.9	2.28	21.9	3.00	16.7	3.77	13.3
1½	1.90				—	—	2.72	18.4	2.72	18.4	3.64	13.7	4.86	10.3
2	2.375	1200			3.66	13.6	3.66	13.7	3.66	13.7	5.03	9.9	7.45	6.7
2½	2.875				5.80	8.6	5.80	8.6	5.80	8.6	7.67	6.6	10.	5.0
3	3.5		1200	1200	7.58	7.9	7.58	7.9	7.58	7.9	10.3	8.3	14.3	4.2
3½	4.	2300		—	9.11	6.6	9.11	6.6	9.11	6.6	12.5	4.8	—	—
4	4.5		1400	—	10.8	6.5	10.8	6.5	10.8	6.5	15.0	4.7	22.6	3.1
5	5.563			—	14.7	4.8	14.7	4.8	14.7	4.8	20.8	3.4	33.	2.2
6	6.625			—	19.0	3.7	19.0	3.7	19.0	3.7	28.6	2.5	45.3	1.6
8	8.625	5200	2000	—	28.6	3.5	24.7	4.1	28.6	3.5	43.4	2.3	74.7	1.4
10	10.75	4900	3000	—	40.5	3.7	34.3	4.4	40.5	3.7	64.4	2.4	116.	1.3
12	12.75			—	53.6	2.8	43.8	3.5	53.6	2.8	88.6	1.7	161.	—0.05
14	14.0	5600	4500	—	63.3	3.6	54.6	4.1	63.3	3.6	107.0	2.1	190.	1.2
16	16.0			—	82.8	2.7	62.6	3.6	82.8	2.7	137.0	1.7	241.	—0.05

* — *Apply factor of safety to allow for corrosion of pipe clamp and temperature-change stresses.*

† — *Safety factor of beam clamp supporting 20 ft. of pipe, not allowing for valves, flanges or cover.*

Bugs About Belting

When your leather belts stretch and fail, don't start cussin' the manufacturer. Recent research reveals that minute bugs (microbes) may have been lunching off the hides before the tanning process was applied

THE EPIGRAM, "A chain is no stronger than its weakest link," may well be paraphrased to, "A belt is no stronger than its weakest spot." Belts made from apparently high-grade leather sometimes mysteriously develop weak spots. Two rolls of belting manufactured from the same grade of leather, perform very differently in service. One has excessive stretch and fails after a comparatively short period of service, but the other one makes a record for long and satisfactory performance. The mysterious offender has been exposed—it's a microbe.

Ferreting out the Bugs

Chas A Schieren Co, in its research laboratories, undertook to determine the hidden factors responsible for excessive stretch and low tensile strength of some apparently high-grade leather belts. The search led right back to the hides as they were received at the tannery. A study showed that many were tainted by bacterial action, resulting from excessive manure being left in the hair of the hide at time of removal from the animal. Results were that the salt preservative applied after the animal is skinned, couldn't properly protect the hide and bacteria attacked the fibers.

Under the microscope, hides free from bacterial growth show firm intertwined fiber, the basis of tensile strength in finished leather belting. A photomicrograph of leather made from such a hide is shown in Fig. 1. A firm well knit fiber structure is evident in this sample. Tests on leather of this quality showed a stretch of 9.8% and a tensile strength of 5900 lb per sq in.

Hides that had been attacked by bacteria showed large areas where the fiber bundles were eaten out, thus weakening the structure. Leather made from such hides has a typical cross-sectional appearance under the microscope, Fig. 2 (note how the interlocking of the fiber bundles has been destroyed). This leather under test stretched 14.7% and failed at a load of 3750 lb per sq in.

Over 2,000 hides, part bacteria free and part bacteria tainted, were studied under all conditions, from the time they were received until they were finished belt leather. The tests show that there is a definite relation between bacterial damage to the hide and strength and stretch of the finished leather. The company is now able to classify its leather-belting cuts into two groups, one having low stretch and an average tensile strength of 5500 lb per sq in, and one with an average tensile strength of 3700 per sq in. and high stretch. Government specifications require for single-leather belting an average strength of 4,000 lb per sq in. with no sample falling below 3,000 lb per sq in., and with a maximum allowable stretch of 15% when subjected to a load of 6 to 8 times normal working strain in the belt, which is approximately comparable with the lower value given above.

Not the Entire Answer

Of course, all the trouble experienced in leather belting cannot be attributed to bacteria. Tanning processes, parts of the hide used for belt stock and other factors must be considered. But the fact remains, that if a hide has not been properly preserved before tanning, no amount of tanning and treatment will make high-grade belting stock.

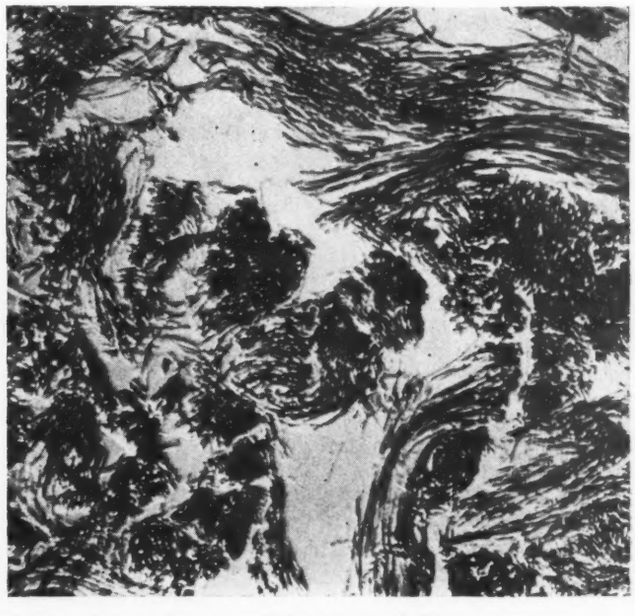


Fig. 1—Cross section of bacterial-free belting, enlarged 100 times, shows well-interlocked fiber structure
Fig. 2—Bacterially damaged leather belting. Note that fiber structure has been eaten away by microbes

Speaking of Power

On page 68 of this number, John Drabelle, our old friend of Iowa Electric Light and Power, gets down to brass tacks on the subject of diesel-plant operating records. As always, he is simple, direct and practical. He speaks from a very extensive operating experience. His record forms and suggestions will be helpful to diesel operators everywhere.

Many an engineer has complained to the chemists, "You don't speak our language." Too true and too bad! The chemists, like the doctors and most other highly specialized professionals, have developed their own private jargon. It may mean a lot to a chemist, but it's generally a headache to the

. . . chemists' own jargon

power engineer seeking the chemist's help on his practical problems. . . . And hereby hangs a tale. Some months ago I had a heart-to-heart talk on this matter with C H Fellows, Chairman, Joint Research Committee for Boiler Feedwater Studies. We agreed 100% that knowledge is useless until transmitted to the men who can use it. . . . We also agreed to do something about it. On a recent trip to New York, Mr Fellows gave me a lot of his valuable time for the interview reported on page 81. He had promised me he would give plain unvarnished answers to my questions on boiler embrittlement, and he certainly delivered the goods. I consider this interview the clearest statement yet published on this matter of such vital importance to power engineers everywhere. . . . For the good of the cause, we are running off a few reprints and shall be glad to mail one or two copies each, while they last, to interested readers. Probably there are many who want to know how things stand today and what new steps are expected.

A reader in the rubber industry has put me gently but firmly on the pan for my statement (July *Power*, page 76), "As far as I know, only two 'superheated water' systems have been installed in the United States to date. Both are used for process

. . . 1000 tires cured daily

heating in plastic factories". . . . Taken literally, this is an error, because some of the tire and rubber companies are using process water at temperatures above 212 deg. to vulcanize tires. Note, however, that these installations are not "central systems" in which the superheated water is taken directly from the boiler drum, circulated through the plant and then returned at lower temperature to the boiler. Instead, the water is "superheated" by steam in heaters close to the process. . . . There are several obvious reasons for this arrangement. In most tire factories the vulcanizing department is distant from the boiler house and the quantity of water required (100 gpm per 1000 tires cured daily) would hardly warrant a central system. Moreover, the water, coming in direct contact with rubber, picks up sulphur compounds so that it could not be returned to the boilers without expensive treatment. . . . So, it is still true, I understand, that there are only two *central* systems of superheated water in this country. If anybody has any information to the contrary, let's have it.

These days theory is having its innings. Many engineers are having a lot of fun with their differential equations. That is quite all right—those contraptions have their uses—but I'm

. . . moved to restore balance

moved to restore the balance by harping once more on the solid virtues of the good old-fashioned Yankee mechanic. Today, as always, there's a field for his kind of skill and imagination. When it's combined with business sense, engineering knowledge, or both, you have a man who can go places in this mechanical world. Remember this: Versatility, *practical* versatility, is rare, and commands a corresponding premium in the worlds of business and engineering.

This line of thought reminds me that some of America's most successful engineers and business men were once plain mechanics — generally mighty good mechanics. You all know about Ford and Chrysler. . . . Another example is Alex Dow,

. . . some were once mechanics

president of Detroit Edison. When he first came to this country many years ago, Mr. Dow worked first as a telegrapher and then as a wireman. Said he in a recent speech: "I was not born into my industry with a silver spoon in my mouth. I went in with a kit of tools on my shoulder. - - - I was a good wireman, earning the top pay of those days, three dollars for a 10-hour day."

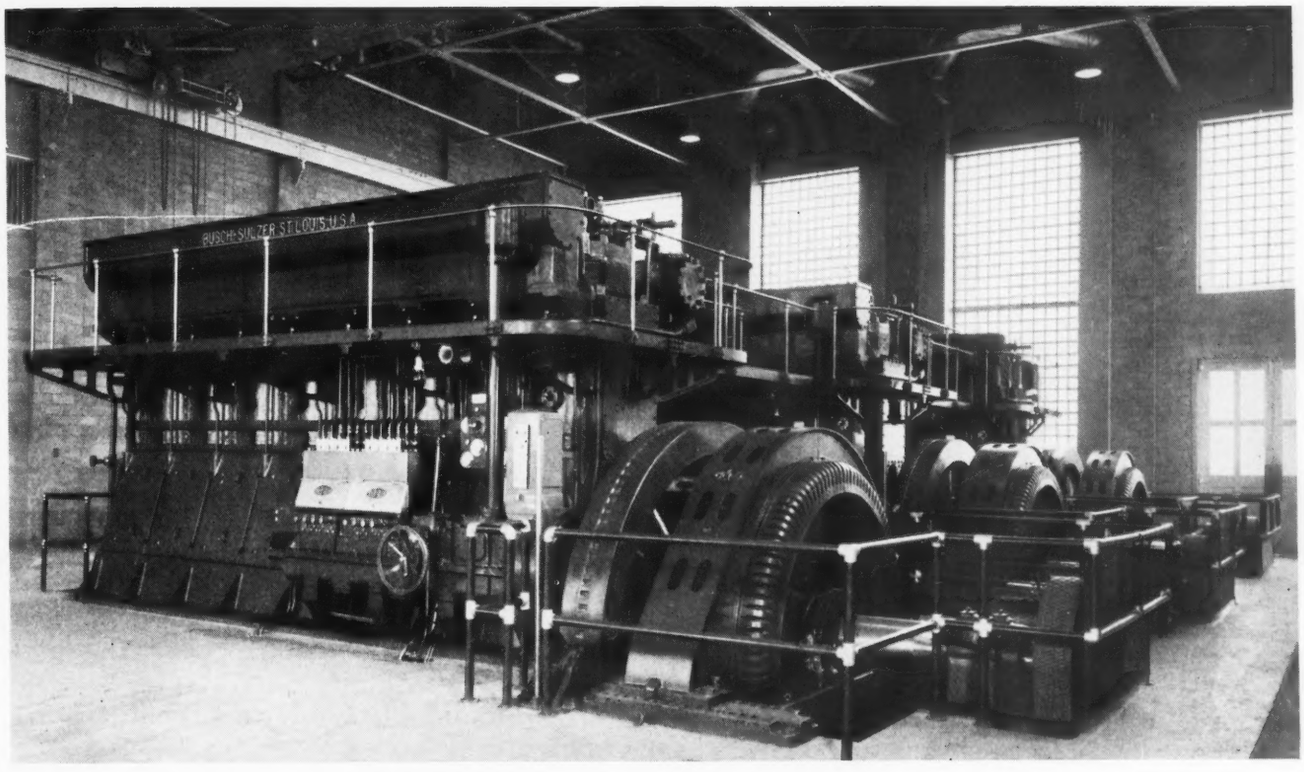
Engineers might as well make up their minds that noise prevention is going to be one of their major jobs. Some orders for machinery now specify maximum permissible noisiness in "decibels"—electrically measured. Already many manufacturers have set up test rooms for measuring the racket produced by fans, gears, etc. . . . I was recently in such a padded cell (please don't misunderstand me). Walls were a foot thick. The room was hung freely on springs, and had a door like that of a bank vault. When that door closed on you an outside noise equal to the roar of a passing train was like the ticking of a small watch. . . . Within this haven the new

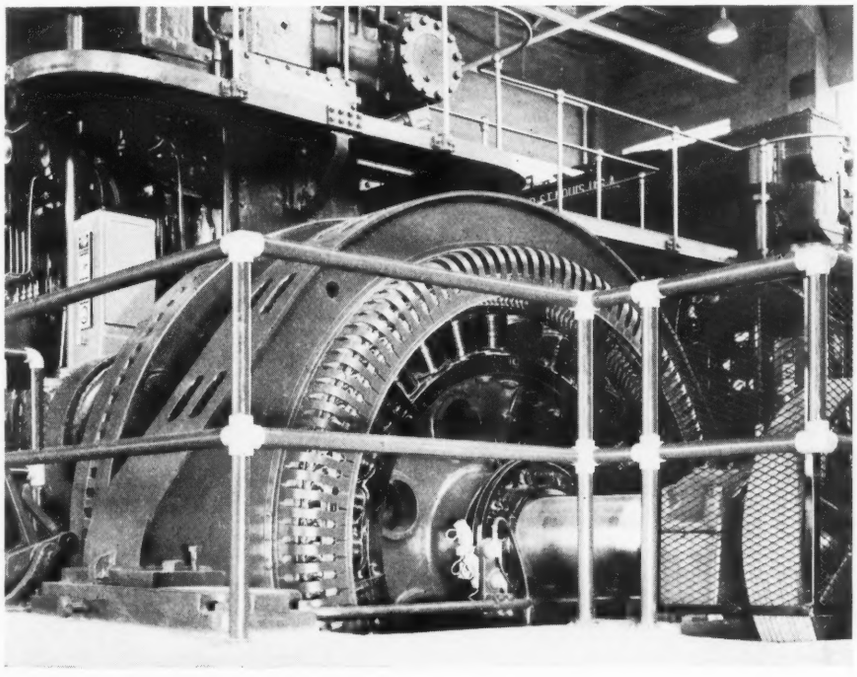
. . . in a padded cell

fangled machine doctor applied his electrical "stethoscope" to motors, gears, compressors and other equipment.

In their early crude forms, the products of the engineer were responsible for such evils as smoke, dust, stream pollution and noise. This was only natural. There was a pioneer job to be done and pioneers don't worry much about personal comfort. But those days are rapidly passing. The engineer must now use his mechanical knowledge to cure these machine-created evils, so that some day the machine will be a rose without thorns. Beyond any question, that is possible . . . Speaking of noise, have you noticed how many of the new public assembly rooms and public dining rooms are equipped with the perforated sound-absorbing ceilings, so that patrons can hear themselves think above the hubbub of conservation and clatter of table ware? . . . Which also makes me wonder whether the definition of air conditioning may not be extended some day to include elimination of irritating sound waves in the air.

PHIL SWAIN, Editor





RURAL POWER

SOMEDAY 12,000 farms will take light and power from the Wisconsin Power Cooperative system, fed by this diesel-electric station near Chippewa Falls, Wis. Financed by Federal funds, under the Rural Electrification Administration, it is believed to be one of the first plants to supply electricity for rural use exclusively.

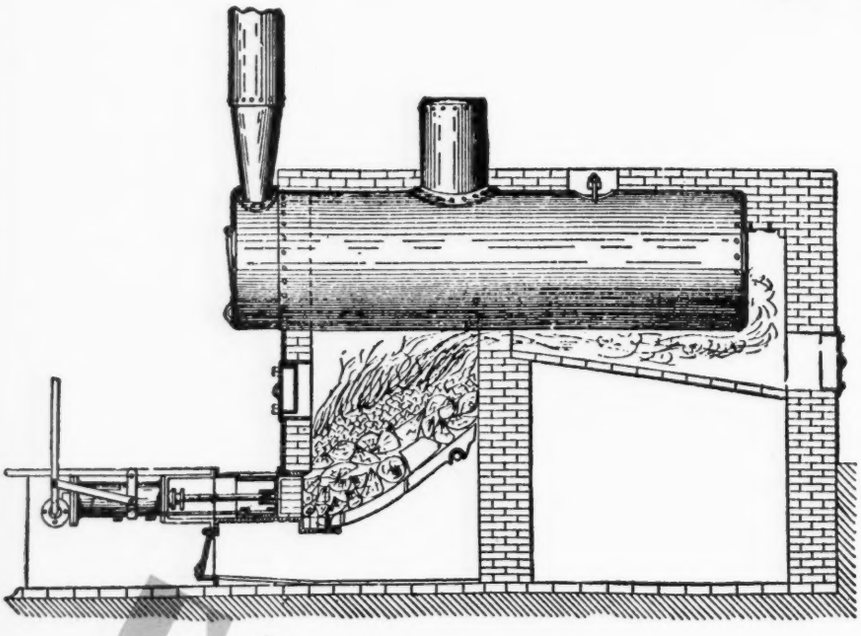
Ten member cooperatives buy wholesale power from this generating center, taking delivery at 33,000 v over more than 200 miles of transmission lines. Substations step down to 7200 v for distribution to individual farms and retail sale at 120-240 v.

Top—These 1000-hp, 8-cyl, $16\frac{1}{4}$x $24\frac{1}{2}$-in., 257-rpm Busch-Sulzer diesels are 4-cycle solid-injection machines with a fuel consumption of 0.39 lb per hphr

Above—Power is generated at 2500 volts in three 875-kva, 0.8-pf, Electric Machinery Mfg Co generators

Right—Placed in service in March and dedicated in May, 1938, this 2100-kw diesel generating station serves farm users in eleven counties in western Wisconsin

1888 THE GOLDEN OF JONES



1938 is the Golden Anniversary of the Jones Stoker. Back in 1888 Evan Jones invented and built the first underfeed stoker. This was the start of underfeed stoking or what is sometimes known as forced underfiring. The Jones Stoker is the Daddy of all underfeed stokers.

FIFTY YEARS

● **It is a far cry from the first Jones Stoker to the highly developed efficient Riley-Jones Stoker of today. The present-day Riley-Jones Stoker has fifty years of stoker designing and manufacturing experience back of it. It represents fifty years of stoker progress.**

● **Continually since the invention of the Jones Stoker fifty years ago, improvement after improvement has been applied, so that today its many outstanding features make it preeminent in its field. Continuous improvement has been necessary to maintain its leadership — to attain its present age of fifty full years.**

● **Throughout these years, the Jones Stoker has established the reputation of paying for itself, then paying dividends.**

● **The Riley-Jones Stoker of today, because of many recent improvements, does a better job than ever of paying for itself through savings in fuel and labor. It is absolutely reliable, highly efficient and operates with low maintenance.**

TRADE MARK Rx REGISTERED

RILEY

STOKER CORPORATION, WORCESTER, MASS.

Boston New York Philadelphia Pittsburgh Buffalo Cleveland Detroit Tacoma Baltimore Milwaukee Denver
St. Louis Cincinnati Houston Chicago St. Paul Kansas City Los Angeles Atlanta Memphis New Orleans

It will pay you to visit modern Riley Installations

ANNIVERSARY STOKERS 1938

of Stoker Progress

● **When considering side dumping stokers, be sure to take advantage of Riley's fifty years of stoker experience by consulting a Riley engineer. He will advise you as to the savings which can be made by installing Riley-Jones Stokers. Riley-Jones Stokers are manufactured in sizes from 25 H.P. up and in varying widths and lengths to fit requirements of each individual plant. They can be either mechanically, hydraulically or steam operated.**

THE GOLDEN ANNIVERSARY . . . RILEY-JONES STOKER

A survey of your power plant by a consulting engineer will possibly show ways of making surprisingly large savings in power costs

COMPLETE STEAM GENERATING UNITS

BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • AIR HEATERS
ECONOMIZERS • WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • FLUE GAS SCRUBBERS

before purchasing Boiler or Fuel Burning Equipment

Number 74

Investment for $1 Annual Savings

IF A NEW PIECE of equipment promises to make a *net* saving of a dollar a year for ten years, how much can you afford to pay for it? Ten dollars is obviously too much, as allowance must be made for interest charges. If you have to borrow the money at 5%, or even if you have the money but could invest it otherwise at 5%, calculation shows you shou d spend up to $7.72, no more.

The table gives the amount that can be paid to make a $1 saving each year for any period up to 40 years, at any interest rate from 2 to 8%. For example, $20 saved each year for 15 years at 6% interest justifies spending 9.71 × $20 = $194.20. If a modernization program costs $1000, and must pay out in 8 years at 4% interest, it must make a net annual saving of $1000 ÷ 6.73 = $148.60.

Interest Rate

Years	2%	3%	4%	5%	6%	7%	8%
1	0.98	0.97	0.96	0.95	0.94	0.93	0.93
2	1.94	1.91	1.89	1.86	1.83	1.81	1.78
3	2.88	2.83	2.78	2.72	2.67	2.62	2.58
4	3.81	3.72	3.63	3.55	3.47	3.39	3.31
5	4.71	4.58	4.45	4.33	4.21	4.10	3.99
6	5.60	5.42	5.24	5.08	4.92	4.77	4.62
7	6.47	6.23	6.00	5.79	5.58	5.39	5.21
8	7.33	7.02	6.73	6.46	6.21	5.97	5.75
9	8.16	7.79	7.44	7.11	6.80	6.51	6.25
10	8.98	8.53	8.11	7.72	7.36	7.02	6.71
11	9.79	9.25	8.76	8.31	7.89	7.50	7.14
12	10.58	9.95	9.38	8.86	8.38	7.94	7.54
13	11.35	10.63	9.99	9.39	8.85	8.36	7.90
14	12.11	11.30	10.56	9.90	9.29	8.75	8.24
15	12.85	11.94	11.12	10.38	9.71	9.11	8.56
16	13.58	12.56	11.65	10.84	10.11	9.45	8.85
17	14.29	13.17	12.17	11.27	10.48	9.76	9.12
18	14.99	13.75	12.66	11.69	10.83	10.06	9.37
19	15.68	14.32	13.13	12.09	11.16	10.34	9.60
20	16.35	14.88	13.59	12.46	11.47	10.59	9.82
21	17.01	15.42	14.03	12.82	11.76	10.84	10.02
22	17.66	15.94	14.45	13.16	12.04	11.06	10.20
23	18.29	16.44	14.86	13.49	12.30	11.27	10.37
24	18.91	16.94	15.25	13.80	12.55	11.47	10.53
25	19.52	17.41	15.62	14.09	12.78	11.65	10.67
26	20.12	17.88	15.98	14.38	13.00	11.83	10.81
27	20.71	18.33	16.33	14.64	13.21	11.99	10.94
28	21.28	18.76	16.66	14.90	13.41	12.14	11.05
29	21.84	19.19	16 98	15.14	13.59	12.28	11.16
30	22.40	19.60	17.29	15.37	13.76	12.41	11.26
31	22.94	20.00	17.59	15.59	13.93	12.53	11.35
32	23.47	20.39	17.87	15.80	14.08	12.65	11.43
33	23.99	20.77	18.15	16.00	14.23	12.75	11.51
34	24.50	21.13	18.41	16.19	14.37	12.85	11.59
35	25.00	21.49	18.66	16.37	14.50	12.95	11.65
36	25.49	21.83	18.91	16.55	14.62	13.04	11.72
37	25.97	22.17	19.14	16.71	14.74	13.12	11.78
38	26 44	22.49	19.37	16.87	14.85	13.19	11.83
39	26.90	22.81	19.58	17.02	14.95	13.26	11.88
40	27.36	23.11	19.79	17.16	15.05	13.33	11.92

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NAPE at Grand Rapids

DURING a week of perfect weather Aug 29—Sept 2—Grand Rapids, Mich., entertained the National Association of Power Engineers, assembled for its 56th annual convention. The 243 official delegates on hand represented 16,450 members in 213 associations. Accompanying them were many ladies and visitors.

Convention sessions and exhibits were held in the capacious Civic Auditorium, other events in the Hotel Pantlind. All local arrangements were capably handled by the convention executive committee, of which J J Wernette, (Supt of Grand Rapids Water and Light Plant) was general chairman. Indianapolis was selected as the Convention City for 1939.

New Officers

Vice-president Fred C Laufketter, chief engineer of the Jefferson Hotel, St. Louis, was elected president for the coming year, and Carl R Daubenmire, chief examiner of engineers in Ohio, was elected to the key position of vice-president. Other officers newly elected or continued for 1938-39 were:

Secretary, Fred W Raven, Chicago, (reelected); treasurer, E J Burke, Philadelphia (reelected); trustee, Thomas Gambute, Detroit (reelected); four existing trustees, C A Nelson, Minneapolis, T R Herlihy, Los Angeles, A P Thompson, Kansas City, and W W Downey, New York City.

Doorkeeper, W R Schurk, Meriden, Conn.; conductor, Donald Kurtz, Newark, N. J.; and a board of arbitration consisting of past presidents W J Reynolds, Hoboken, N. J., H W Wilds, New York, N. Y., and J A Prudell, Milwaukee, Wis.

C F Bindrich (left), retiring president, talks with another busy man, secretary Fred Raven of Chicago

Among the speakers at the various sessions were general chairman J J Wernette; Geo W Welsh, Mayor of Grand Rapids; national president Chas F Bindrich; H M Taliaferro, president of American Seating Company; national vice-president Fred C Laufketter; national past president H W Wilds; national secretary Fred W Raven; T W Ross, manager Indianapolis Power and Light Co; Hans Dahlstrand of Allis-Chalmers Manufacturing Company.

As for several years past, much of the discussion centered on the relations between operating engineers and professional engineers, education of engineers, the support of sound license laws, and ways and means of making the nation better acquainted with the NAPE and more conscious of services rendered the community by the power engineer.

Visits, Entertainment

Among the many associated events were a tour through the new $7,000,000 Grand Rapids Stamping Plant of Fisher Body Co, private visits to the Grand Rapids Water Works, an extended sight-seeing tour of Grand Rapids and vicinity, evening of vaudeville entertainment, and public installation of national officers. As usual, the Ladies Auxiliary conducted its own independent program of business sessions and entertainment. Among the featured performances of the annual entertainment were songs by Bobby Jones of Jenkins Co and a military skit by George Allen of Mason-Neilan Regulator Co.

Spaciously housed in the basement of the Civic Auditorium, the 37th annual exhibit featured the products of 50 exhibitors of power equipment. More than 1800 visitors registered in the exhibit hall.

Fred C Laufketter, newly elected president, is chief engineer of Jefferson Hotel, St. Louis, Mo.

Carl R Daubenmire, Ohio's chief examiner of engineers, wins key position of vice-president

J J Wernette, general chairman of the convention, is supt of Grand Rapids Water & Light Plant

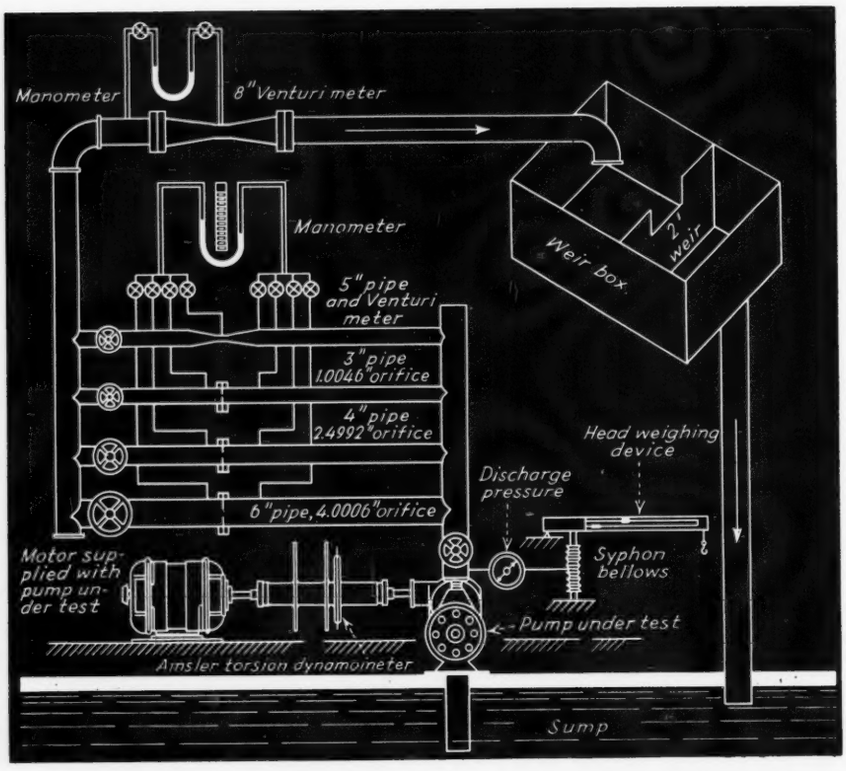


Fig. 1—General arrangement of pump-testing equipment at Stanford University

Pioneer Pump Testing

Stanford pump-testing laboratory gets the lowdown on commercial-size centrifugals that permits separation of hydraulic into shock and friction losses

By J RAY PETERSON
Stanford University, Cal.

STANFORD UNIVERSITY has pioneered in telling the world about pumping machinery. As early as 1902, a course in pumping machinery was started by Prof Albert W Smith, now Emeritus Professor of Mechanical Engineering at Cornell University. Dr William F Durand took over this work in 1904, and continued for 20 years until his retirement in 1924. Prof Charles N Cross, who carried on from 1924 until his death in 1932, was succeeded by the present laboratory head, Prof Volney C Finch, a graduate of Massachusetts Institute of Technology. Over this period of approximately 40 years, there has been developed a testing laboratory which compares favorably with any in the world.

Here a main testing sump with a capacity of over 100,000 gal. is so divided that pump discharge up to 10,000 gpm can be tested. Discharge-measuring equipment comprises a set of accurately calibrated orifices for small and intermediate capacities, venturi meters for small and large capacities and small and large weir boxes with a variety of weir plates. A set of orifices for 6-in. pipe, calibrated for discharging both into atmosphere and submerged, are available for testing pumps in the field, a service performed by Stanford for either pump manufacturers or purchasers. Large calibrated sumps and weighing tanks give accurate calibration of flow-measuring equipment.

Fig. 1 shows the set-up used in obtaining data from which centrifugal-pump hydraulic losses are separated into friction and shock losses. This is typical of one of a number of test arrangements that can be made in the Stanford laboratory. The pump under test is driven by its own electric motor, through the Amsler torsion dynamometer, Fig. 2, which measures power required to drive the pump directly.

Data for determining head produced by a pump are pressures at suction and discharge; elevations of discharge and suction gages; and the velocities in suction and discharge pipes, which may be found by dividing rate of discharge by the areas of the respective pipes. Discharge pressure may be measured by an ordinary pressure gage in field testing or in obtaining operating data. For precision testing, a more accurate instrument must be used—a long mercury column is often employed for heads up to about 200 ft, but since such a column must be at least 15 ft long, difficulty in taking readings is experienced unless mirrors are used.

A device developed in the Stanford testing laboratory, Fig. 3, actually weighs the head. A pipe from the discharge nozzle that would ordinarily terminate in the discharge pressure gage is extended, as in Fig. 1, to a small sylphon bellows. Discharge pressure elongates the bellows and this movement acting through a simple leverage tips the scale beam. A dead-

weight gage tester is attached to the pressure line near the bellows to permit immediate checking of the scale readings. To insure that the pipe connection between the discharge nozzle of the pump and the head-weighing device is filled with water and not a mixture of air and water, valves at all high points drain out air before a measurement is recorded.

Discharge Rate

Discharge rate of a pump is first measured by one of the calibrated orifices or the venturi meter, Figs. 1 and 4. When discharge is great, the lower valve is opened to route the water through the large pipe and orifice. When discharge decreases, water is successively routed through the smaller pipes. The small lines leading from the high- and low-pressure sides of the calibrated orifices may be connected to the mercury manometer, Fig. 1, by manipulation of small valves on either side of the manometer. Calibration curves obtained for the four measuring orifices by weighing the water are placed on the manometer board for ready reference. Design of the flow-measuring bank was based on a similar arrangement designed by Roy Magnuson, chief engineer, Peerless Pump Div, Food Machinery Corp, San Jose, Cal.

After passing through one of the pipes of the flow measuring bank, discharge goes through the 8-in. venturi meter. Measurement of pressure drop with a differential mercury manometer, having one leg connected to the throat venturi tube and another to the upstream section of the pipe, provides an index to rate of flow.

After flowing through the 8-in. venturi tube, the pump discharge empties into a steel weir box. Measurement of pump discharge by weirs is not recommended if other methods can be used. The weir does provide an approximate measurement for rough checking. The steel weir box, Fig. 1, is employed as a third check on the discharge rate, and it shows when steady flow has been established after a change in discharge-valve opening.

Extreme care was used in the design and building of the steel weir boxes for the Stanford testing laboratory. A system of baffle plates straighten out the turbulent flow from the pipeline emptying into the weir box. Water flow is smooth and straight for a length upstream of about thirty times the head flowing through the weir notch. This condition cannot be realized in a short weir box even with elaborate screens and baffles. The bottom edge of the weir-plate notch is placed at a distance equal to over twice the maximum head on the weir above the weir-box bottom. The result of these precautions is smooth straight flow as the water approaches the weir notch.

The hook gage used to find water elevation over the weir is upstream from the weir notch at a distance equal to about 10 times maximum head. Prof U A Patchett of Stanford has developed an electric hook gage that completes an electric circuit to light a neon bulb when the gage point touches the water surface. Scale readings are in 0.1, 0.01 and 0.001 ft, and it zero is obtained with a level. Water, after flowing over the weir notch, falls into the sump to be recirculated by the pump.

Primary Purpose

The primary purpose of the laboratory is the instruction and development of student engineers who eventually may either accomplish further improvements in efficiency of pumps or reduce their cost without reducing reliability or efficiency. The thoroughly equipped testing laboratory has proved to be an important factor in this work, and the incidental service given to pump manufacturers and purchasers has been well received.

While it has been generally recognized for some time that centrifugal-pump designers should know how hydraulic losses are distributed, it is a recent idea that it is equally important for the operating engineer and waterworks superintendent to know the possible variations of these losses and apply this knowledge in buying pumping equipment. It is to the operating engineer's advantage to understand the factors that underlie the hydraulic losses of centrifugal pumps, because he is then enabled to take full advantage of modern improved performance by selecting not just an efficient pump, but the most efficient pump for the job in question.

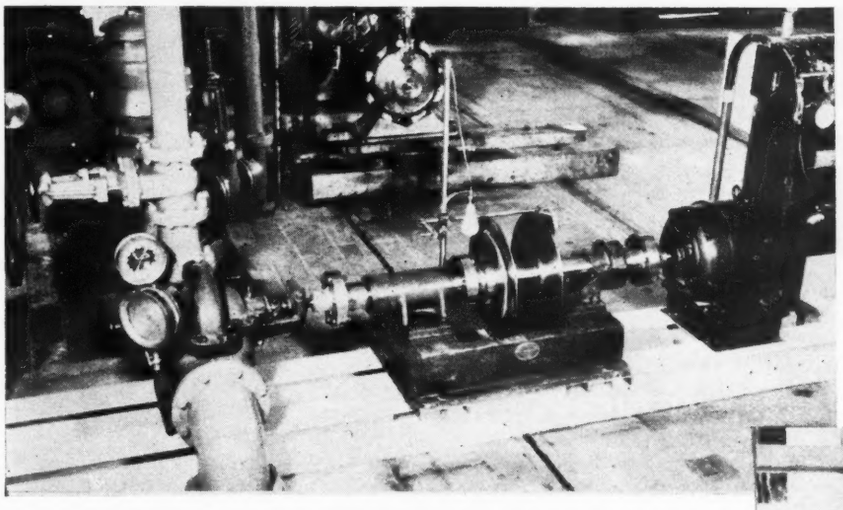


Fig. 2—Pump at left is under test, driven by its own motor through a torsion dynamometer

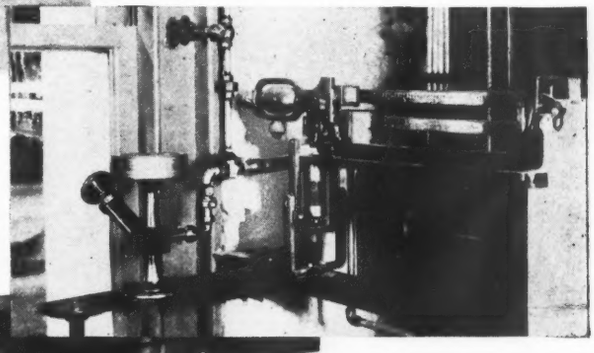


Fig. 3—Head produced by the pump under test is weighed on this apparatus

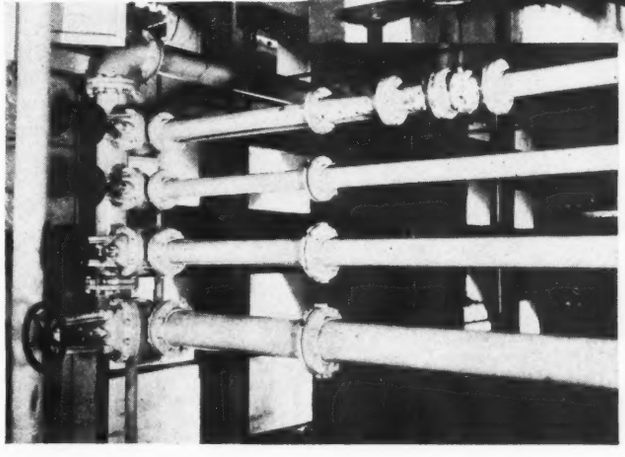


Fig. 4—Calibrated orifices and venturi tube are used as primary standards for measuring pump discharge

Plain Talk on Embrittlement

(*Continued from page* 83)

ing. We chemists have tackled a big job and, as sometimes happens, we have made a lot of false starts. Yet always there is progress. We know that all further search for the practical cure of embrittlement must start with two demonstrated facts: First, embrittlement is basically a problem of selective corrosion; that is, a type of rusting that occurs only on certain parts of the metal surface, such as on the grain boundaries instead of on the grains as well. Second, sodium hydroxide may be the "cause", but whether it operates or not depends on the presence or absence of silica (and possibly other substances), as well as on concentration and temperature.

But, Mr Fellows, I still don't see how this is any help today to the average engineer in the average boiler room. What is he going to do while the chemists are chasing the final solution?

To get right down to brass tacks, Mr Swain, we are well on our way toward a final solution of this problem, but obviously we haven't found it yet. Certain materials that have proved infallible so far in laboratory tests still await the final proof of complete dependability in actual service.

What materials?

I have in mind, first, the so-called "lignins", which are contained in paper-mill sulphite waste liquor; second, sodium chloride (common salt); third, R_2O_3 (R-Two-O-Three). Let's take them up one at a time. Remember that no one of them is as yet an officially established "cure", nor is any one of them to be recommended for general use, pending wider experience.

What about these lignins?

Many laboratory tests, plus quite a bit of operating experience (but only in locomotive boilers), indicate that proper amounts of lignins will prevent embrittlement in boilers operating at pressures below 550 lb. At higher pressures the temperature will decompose the lignins, so that they will be of no value.

By the way, this supposed lignin cure of embrittlement was one of those lucky accidents. One railroad had been using them for 25 years or so as a part of an anti-foaming compound, and some 15 years ago the engineers of this road noticed from their own records that locomotive boiler embrittlement never occurred where such material was used although it did occur elsewhere. A treatment was then developed that employed materials of the lignin type, and this was used generally on the system. Embrittlement, formerly very common, ceased entirely as soon as the lignin treatment was started and has never recurred.

Dr. Schroeder and his associates, attacking the problem from another angle, argued that whereas embrittlement sometimes occurred in caustic evaporators and digestors of aluminum ores, it never occurred in wood digestors, in the paper industry, using strong caustic solutions. Something in the wood, perhaps, prevented the embrittlement, and since lignin was one of the caustic soluble materials found in wood, experimentation with it began. The laboratory tests, so far, have completely confirmed the field experience of the railroad company. The lignins seemed to form a self-healing protective film over the grain boundaries.

How about that sodium chloride, or common salt, cure?

Professor Straub has had a lot of success with it in his laboratory tests. He merely maintains a sodium chloride concentration about 60 per cent of the total alkalinity expressed as sodium carbonate. Under these conditions, if a little sodium sulphate is also present, he finds that the combination prevents embrittlement of test specimens up to steam pressures of 400 lb.

You mentioned another supposed cure. I think you called it R_2O_3. What's that?

R_2O_3 is the chemist's abbreviation for the combined oxides of iron and aluminum. They exist in all waters, although generally in small amounts. Professor Straub found, at pressures above 450 lb, that cracking of his test specimens stopped abruptly when R_2O_3 was added to the water in sufficient quantity.

Which of these possible cures do you suggest that the operator try?

I don't suggest that he try any of them of his own initiative in the present state of our knowledge.

Well, then, what can he do?

Let's consider two cases. In the first case, the operator has been operating the boilers in question over a period of years without any embrittlement trouble, and in the second, he is about to start up a new boiler in a new location. Let's take this first case, if he has had no trouble there seems little reason why he should change his procedure. Three reasons for his freedom from embrittlement are possible under such circumstances: (1) His boiler water is not of an embrittling nature. (2) His boiler has no seams or crevices in which high concentrations can develop, and (3) If there are such seams, they do not exist at points where high stresses occur in the metal. You see, if the water is going to corrode the metal to cause embrittlement, it *must concentrate at a point where abnormally high stresses occur.* Now, considering the second case, the operator would do well to consult an authority on this subject and have the boiler water tested to determine if it is of a nature that will cause embrittlement.

A third case may be considered, not greatly unlike the second. In this case, the experience of the operator indicates he may have an embrittling water, and others using water from the same source treated in a similar way are experiencing such difficulties. In this instance, I suggest that he send a sample of his boiler water to one of the university laboratories which is now equipped to test its embrittling action on metal under stress at actual boiler temperatures. If this test shows the water will not embrittle steel, I would suggest no change in operating procedure. If, on the other hand, the boiler water is found to embrittle the test specimen, I would recommend that the operator consult a specialist before attempting to dope his boiler with lignins, common salt, R_2O_3, or other possible cures.

Well, I guess that's that. What's being done to get better information for the operator?

A lot. For example, Professor Straub is doing a great deal of test work at Illinois on actual boiler water. Dr. Schroeder, working under the auspices of the Joint Research Committee on Boiler Feedwater Studies, as you may know, is chasing down the clues already unearthed. Right now experience data are being gathered under actual operating conditions, on the action of lignins, sodium chloride, and R_2O_3.

It is my personal conviction that in another year, probably, we shall have a great deal more data substantiating these laboratory findings, if the committee can find the necessary funds to support this extensive program.

Power Lines

50,000-Kw Unit for Essex Station

An additional generating unit (3600 rpm, 50,000 kw) has been placed in service at the Essex Generating Station of Public Service Electric and Gas Co (N. J.). With the new unit, the station has seven turbine-generators with total capacity of 243,000 kw.

Eight of the original boilers in the central section of the station were removed and their place taken by two new boilers which will evaporate 300 tons of water per hr into steam at a pressure of 1250 lb per sq in. and a temperature of 900 F. They have dual firing facilities that permit burning of either pulverized coal or fuel oil, or both simultaneously. Approximately 1100 tons of coal or 4900 barrels of fuel oil will be burned under these two boilers daily.

Applications Made for Wis. Hydro Projects

Three applications for licenses to construct hydroelectric projects in Wisconsin were received recently by the Federal Power Commission. The Consolidated Water Power & Paper Co, with offices at Wisconsin Rapids, plans to construct and operate an extensive power project on the Wisconsin, Upper Fox and Little Eau Pleine Rivers in Juneau, Adams, Portage, Marathon and Columbis counties, in the region of Wisconsin Dells-Mauston, New Lisbon, Necedah, and Portage, comprising the following:

Germantown Works: Construction on the Wisconsin River of a concrete dam and earth dike; a power house and installation of hydraulic turbines, generating equipment and transmission lines. The main dam and power house will have a length of about 1550 ft, creating a maximum head of about 28 feet. Equipment is to comprise four hydroelectric units with turbines, each of 5450 hp at maximum efficiency and 6750 hp at full gate opening when operating under a net head of 26 ft.

Pentenwell Works: Construction on the Wisconsin River, in the vicinity of Necedah, of a concrete dam, earth dikes and power house to create a maximum head of about 42 ft, generating equipment and transmission lines. The main dam and power house section will have a length of about 1500 ft. Eight hydroelectric units are to be installed, with turbines of 8000 hp each at maximum efficiency and 10,250 hp at full gate opening when operating under a net head of 40 ft.

Consolidated Water Power Co has applied for license to construct on the Wisconsin River, in the region of the City of Stevens Point and the villages of Knowlton and Dancy, a concrete dam and earth dike and a power house which will create a maximum head of 27 ft. Equipment for this station is to consist of three hydroelectric units, each with a turbine of 4130 hp at maximum efficiency and 5100 hp at full gate opening when operating under a net head of 23 ft.

230 Plan Exhibits for Annual Power Show

Anticipating an upswing in business activity during the coming fall and winter, exhibitors at the 13th Annual Exposition of Power and Mechanical Engineering are planning comprehensive and informative product displays. The Exposition will be held at Grand Central Palace, New York, N. Y., during the week of Dec 5-10, and more than 230 manufacturers have already engaged exhibit space. The Exposition is being conducted and arranged by the International Exposition Co, of which Charles F Roth is president.

ASME Fall Meeting

Papers to be presented at the Fall Meeting of the ASME, Providence, R.I., Oct 5-7, include the following on fuels and power: "High-Pressure Installation at L Street Station, South Boston", by G A Orrok, Jr; "Discharge Temperatures from Pulverizers", by Ollison Craig; "Industrial Power-Plant Steam and Power Generation", by R D Booth; "Atomization of Oil by Small Pressure Atomizing Nozzles", by E B Glendenning, L H Ventres, W A Sullivan, and A R Black.

"Condenser-Tube Life vs Design and Mechanical Features of Operation", by A J German; "Condenser Performance With Reduced Cooling Surface", by J H Harlow and R A Bowman; "Control of Slime and Algae in Industrial Cooling Waters", by H K Nason and J D Fleming; "Industrial-Evaporator Design, Application and Operation", by W K Adkins; and "Industrial Application of Evaporators in No. 1 Power House of the Ford Motor Co", by W W Dulmage.

WPA Grants for Power-Plant Construction

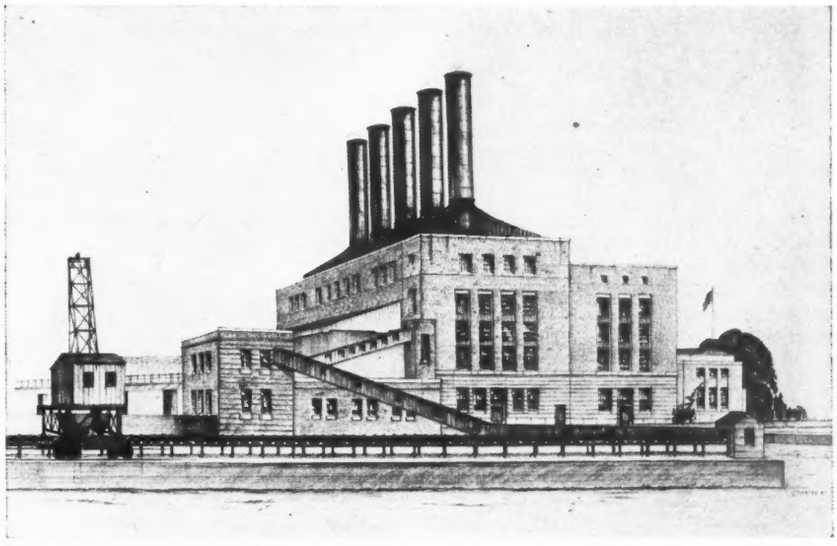
During the month of August, the WPA made the following allotments for power-plant construction and repair:

Alexandria, Minn.—$73,100 of a total cost of $162,465 for improvements to municipal generating and steam-heating plant, including land purchases.

Easton, Md.—$41,085 of a total cost of $91,300 for improvements and extensions in municipal distribution system.

Fremont, Neb.—$126,450 of a total cost of $281,000 for alterations and improvements to municipal power system, including land purchase to enlarge capacity and provide power for nearby REA projects.

Florence, Kan.—$51,300 of a total cost of $114,000 for construction of a diesel-



ARCHITECT'S DRAWING OF PROPOSED CENTRAL NEW YORK STATION

Niagara Hudson Power Corp gave the go-ahead signal Sept 8 on a $9,500,000 steam plant to be built at Oswego, N. Y., by its subsidiary, Central New York Power Corp. The 80,000-kw turbine-generator, largest to be acquired by the electric utility industry since 1931, will be built by General Electric Co, and the accompanying boiler by The Babcock & Wilcox Co. The turbine, a 3600-rpm, 1250-lb, 900-F condensing unit, will be built in a single casing; generator will be hydrogen cooled. The boiler, to generate steam at 1350 lb and 900 F, will have a capacity of 850,000 lb of steam per hr

electric plant, distribution system and street lighting.

Shelby, Ohio—$90,000 of a total cost of $200,000 for alterations and additions to municipal steam plant.

Burlington, Kan.—$12,000 of a total cost of $26,600 for additions and improvements to existing municipal power plant.

Greenville, N. C.—$168.545 of a total cost of $374,545 for additional steam-generating capacity for existing plant.

Prague, Okla.—$31,909 of a total cost of $70,909 for generating facilities to supply existing distribution system.

Waterville, Kan.—$15,343 of a total cost of $34,100 for improvements to existing plant to resume generation of power.

Neodesha, Kan.—$84,744 of a total cost of $188,320 for improvements to municipal power plant.

Ottawa, Kan.—$204,660 of a total cost of $454,800 for additions and improvements to municipal power plant.

Rayne, La.—$38,250 of a total cost of $85,000 for improvements to municipal power plant.

St. John, Kan.—$36,225 of a total cost of $80,500 for additions to municipal power plant.

Clyde, Ohio—$69,300 of a total cost of $154,000 for improvements to municipal power system, to include installation of 1250-kw turbine-generator with condenser and auxiliaries, brick building to house the unit, cooling tower, and improvements in electrical layout.

Carbondale, Colo.—grant of $18,818 and loan of $23,000 for construction of a hydroelectric plant and distribution system.

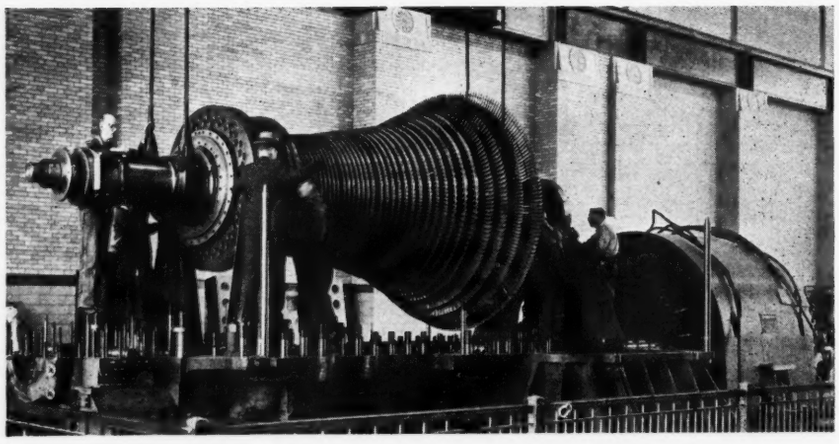
Colorado Hydro Project

Federal Power Commission, on Aug 15, received an application for preliminary permit by Colorado River Commission of Arizona, for proposed 1,100,000 hp hydroelectric development. This project is to be on the Colorado River in Mohave and Coconino counties, Arizona, approximately 80 miles upstream in direct line from Boulder Dam, but considerably farther as the river runs.

The proposed project consists of a dam to raise water surface 570 ft and create a lake 78 miles long, with storage capacity of approximately 2,500,000 acre-ft; and a power plant to have installed capacity of 800,000 hp with provision for 300,000 hp additional capacity with development of upstream storage. A PWA grant to finance 45% of the preliminary work, to cost $165,000, is being sought.

New Turbine-Generator for Kansas City, Kan.

Kansas City, Kan., put into operation July 14 a new 30,000-kw Westinghouse turbine-generator for its municipal power plant. This is the second unit to go into service in the new No. 2 Plant, which already has a 10,000-kw turbine-generator installed in 1932.



ASSEMBLING KANSAS CITY'S TURBINE GENERATOR

Kansas City, Kan., gets a 30,000-kw turbine-generator for its No. 2 municipal power plant, bringing capacity up to 40,000 kw.

Turbine and generator rotors will revolve at 1800 rpm (photograph shows workmen installing turbine rotor). Three boilers already installed, of 180,00 lb per hr capacity each, will suuply steam for both turbine-generators. Duplicate reducing valves and desuperheaters in Plant No. 2 permit supplying steam to the old plant at 175 lb and 478 F, as Plant No. 1 is intended to serve ultimately as standby. Burns & McDonnell Engrg Co prepared plans and specifications. Cost of building extension, equipment and installation was $2,314,251.

Awards Placed for Grand Coulee Generators

Westinghouse Elect & Mfg Co, on its bid of $2,611,000, has received the contract for manufacture and installation in Grand Coulee power house of the three largest generators ever to be built. These three generators will comprise the initial power installation, except for station-service units.

The three machines are to be unity-power-factor, 120-rpm, 13,800-volt, 3-phase, 60-cycle, vertical-shaft, 105,000-kw ac generators. For complete information on the Grand Coulee power project, see the article on page 78 of this issue.

Awards for Papers on Instruments

An instrumentation contest with a first prize of $200.00 in cash is announced by the Industrial Instrument Section of Scientific Apparatus Makers of America.

Twelve prizes in all, totaling $500.00, will be awarded. The contest is open to any engineer or operating man, not employed by an instrument manufacturer. Each contestant is to write about an *unusual application of a standard* instrument or control device, telling briefly what conditions or need impelled the application. By instrument or control device is meant any device used for measurement or control in a plant or laboratory, or any accessory used with a device for measurement and control.

The contest closes November 15, 1938 and the judging will be held during the week of December 5th. Copies of the contest rules and official entry form can be obtained from Scientific Apparatus Makers of America, 20 North Wacker Drive, Chicago, Ill.

OBITUARIES

NATHAN CHENEY, 66, a member of the mechanical engineering staff of Stone & Webster at Boston, Mass., for about 37 years, died of heart attack at his home in Belmont, Mass., in August. He was a graduate of Massachusetts Institute of Technology, and retired last winter from Stone & Webster.

WILLIAM E SUTHERLAND, 53, chief engineer of the United Fruit Co at Boston, Mass., died on Aug 28 at Boston. He was born in Nova Scotia, and had been connected with the company for the past 19 years.

GEORGE R RAYNER, 67, executive vice-president of The Carborundum Co, and one of the most prominent industrial leaders of Niagara Falls, died at his home in Lewiston Heights, N.Y., Aug. 15, after an extended illness dating back to July, 1937.

WILLIAM M H BECK, 76, former president of the Massachusetts state branch of the NAPE's predecessor, the National Association of Stationary Engineers, died Sept 9 at Everett, Mass. Mr Beck sponsored the enactment of the Massachusetts code of boiler rules and the state license law, and served for two terms on the enforcing board under Govs Guild and Draper.

R B BEALE, 60, manager of General Electric's Turbine Div of the Central Station Dept at Schenectady, N. Y., died of a heart ailment Sept 11. Mr Beale had been continuously associated with General Electric since 1899, when he entered the organization as a test man. In 1901 he joined the DC Engineering Dept, and the following year was trans-

ferred to the Commercial Lighting Dept, now the Central Station Dept. He was transferred to the Turbine Dept in 1907, and in 1922 was appointed assistant sales manager of that department. Mr Beale was named manager of the Turbine Sales Div in Jan 1933, on the retirement of E E Gilbert.

JASPER H FISHER, 60, president of Fisher Governor Co, Marshalltown, Iowa, died recently at Orange City, Calif., after an illness of several months. Mr Fisher, who had been active head of the company for the past 25 years,

was educated in the public schools of Marshalltown and attended Iowa State College at Ames. Following that, he spent a number of years in sales work before becoming associated with Fisher Governor Co. The organization, at the time Mr Fisher joined it, consisted of 14 people; today, it numbers over 300.

JOHN HOLMES, 71, president and treasurer of the Holmes Iron Co, Rutland, Vt., died at his home in Rutland of a heart attack on Aug 18.

JAMES TRIBE, 82, with the engineering staff of Allis-Chalmers Mfg Co for nearly 40 years, died Aug 13. Born in Oxford, England; Mr Tribe came to America and started to work for the George H Corliss Co of Providence, R.I., in 1881. In 1890 he opened a consulting office at Providence. In 1893 he became connected with Hoffman-Billings Co of Milwaukee when this company began to design and develop Corliss steam engines. With Allis-Chalmers, Mr Tribe was identified with design and engineering of blowing engines in particular.

PERSONALS

ALBERT D PORTER has been appointed factory representative for the Heating Div of Fedders Mfg Co, Inc, Buffalo, N. Y. Mr Porter will cover Cleveland and adjacent territory, with offices at 1836 Euclid Ave.

ROBERT J DAVIS has been elected president of The Johnston & Jennings Co, Cleveland, Ohio, manufacturers of the Stowe stoker. Mr Davis, who succeeds Tracy J Calhoun, has been a director of Johnston & Jennings for the past 2½ years, and is a grandson of the late Robert Johnston of Cleveland, one of the founders of the company in 1884. Mr. Calhoun has been named chairman

Meetings

American Society of Heating and Ventilating Engineers—*Annual meeting, Jan. 23–26, William Penn Hotel, Pittsburgh, Pa. Secretary, A V Hutchison, 51 Madison Ave, New York, N. Y.*

American Society of Mechanical Engineers—*Fall Meeting, Oct 7–9, Biltmore Hotel, Providence, R. I. C E Davies, secretary, 29 W 39th St, New York, N. Y. Also, ASME annual meeting, Dec 5–9, New York, N .Y.*

ASME and AIMME Coal Conference—*Joint Meeting, Oct 13–15, Palmer House, Chicago, Ill. C E Davies, secretary, 29 W 39th St, New York, N. Y.*

American Welding Society—*Annual Meeting (in conjunction with Metals Congress Exposition), October 17–21, Detroit, Mich. M M Kelly, secretary, 33 W 39th St, New York, N. Y.*

National Exposition of Power and Mechanical Engineering—*Dec, 5–10, Grand Central Palance, New York, N. Y. Charles F Roth, manager, International Exposition Co, New York, N. Y.*

of the board, Hart H Fleming continues as vice-president of the company, and H C Huston is sales manager of the Stoker Div.

GEORGE L DAVIS has been appointed vice-president in charge of sales of the Diamond Power Specialty Corp, Detroit, Mich. Mr Davis, who joined the Diamond organization in 1924 as a member of the Chicago sales office, has been assistant sales manager at the main office in Detroit since 1926.

Prior to joining the Diamond Power Specialty Corp, Mr Davis was for four

years in both Operating and Sales Depts of the Oliver Iron & Steel Corp, Pittsburgh, and for two years in the Sales Dept of the Calorizing Co, Pittsburgh. Mr Davis was graduated from Lafayette College with a degree in mechanical engineering. During the World War, he served as Second Lieutenant Pilot in the USA Air Service.

H L HUXSTER, Darby, Pa., has been named district sales representative in southeastern Pennsylvania and southern New Jersey for Trico Fuse Mfg Co, Milwaukee, Wis.

J L SINGLETON, who has been in charge of Allis-Chalmers Mfg Co's Denver, Colo. district office, has been appointed manager of that office.

J E TOBEY, manager, Fuel Engrg Div, Appalachian Coals, Inc, has been chosen to serve on the Public Service Committee of the national Smoke Prevention Assn, Inc, during 1938-39. The appointment was made by William Culbert, smoke inspector of Nashville, Tenn., president of the association. Another Cincinnatian, Frank H Lamping, executive secretary, Smoke Abatement League of Cincinnati, has also been named to serve with Tobey on this committee.

FLOYD T HAGUE, formerly manager of Westinghouse Elect & Mfg Co's DC Engineering Dept, has been made manager of engineering of the Steam Div,

Westinghouse South Philadelphia Works. Mr Hague joined the Engineering Dept of Westinghouse Co after being graduated from Western University of Pennsylvania in 1911. After obtaining experience in various design sections of the Power Engrg Dept, he was placed in charge of dc machines and synchronous converters in 1925.

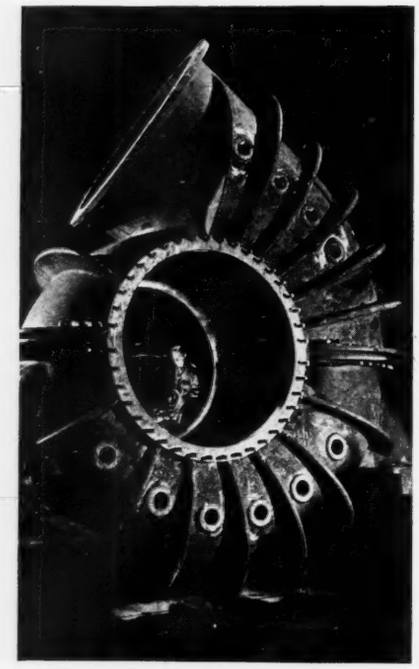
BUSINESS ITEMS

WORTHINGTON PUMP & MACHINERY CORP, Harrison, N.J., has made several changes in oil- and gas-engine sales personnel. J C Barnaby, former manager of the Oil and Gas Engine Application Div at Buffalo, N.Y., has been placed in charge of special engineering work covering engine research and design. W E Wechter, in charge of engines sales in the Atlantic Div, has been transferred to Buffalo to succeed Mr Barnaby. In the Atlantic Div, oil-engine sales will be covered by H C Wood, while W L Russell, at Harrison, N.J., will take over gas-engine sales.

THE STRAIGHT LINE ENGINE CO, INC, founded in 1880, and The Direct Separator Co, Inc, founded in 1894, both of Syracuse, N.Y., have merged to form The Straight Line Foundry & Machine Corp. The business of each will be continued as before under The Straight Line Div and The Direct Separator Div, respectively, of the new corporation.

THE ASHTON VALVE CO, Cambridge, Mass., has appointed T E Nott, 122 Brevard Ct, Charlotte, N.C., as distributor in North and South Carolina, for safety valves, gages, etc.

ALLIS-CHALMERS MFG CO, Milwaukee, Wis., has moved its Dallas, Texas office, of which E W Burbank is manager, to 1800 N Market St, where the Power, Electrical and Industrial Divs will occupy an entire building.



SEWAGE SNAIL

45,000-lb, cast-iron, centrifugal-pump casing belonging to one of four 72-in. double-suction sewage pumps now under construction in the shops of Allis-Chalmers Mfg Co for the Sanitary District of Chicago, Racine Pumping Station. Each complete motor-driven pumping unit will weigh 135,000 lb and will be capable of pumping 375 cu ft per sec of raw sewage and storm drainage at 138.4 rpm against a head of 19.5 ft.

STRAWS

Pointing the way business winds blow

ALABAMA——Board of Education, Selma, plans central heating plant in new high school on Broad St. Cost about $250,000. Bids will be asked soon. Raymond Sizemore, Vandiver Bldg, Montgomery, architect.

CALIFORNIA——J Frank Ruppenthal, Los Angeles, 1308 4th Ave, architect, plans ice and refrigeration plant for ice-skating rink at Community Clubhouse grounds, West Los Angeles. Project will require about 17 miles of refrigerating pipe lines. Cost over $400,000.

City Water Dept, Sacramento, plans 3,000,000-gal. reinforced-concrete elevated storage tank for water system. Cost about $200,000. Dewell & Earl, 55 New Montgomery St, San Francisco, consulting engineers.

Board of Education, Glendale, plans central heating plant in Woodrow Wilson junior high school group. Cost close to $600,000, of which $269,382 will be a Federal grant, Erwood P Eiden, 106 East Wilson Ave, Glendale, and William Mellema, 1661 Beverly Blvd, Los Angeles, architects.

COLORADO——Carbondale plans municipal hydroelectric plant and electrical distributing system. Cost close to $42,000. Financing has been arranged through Federal aid.

Colorado Springs plans extensions in municipal hydroelectric plant, including new 2500-kw hydraulic turbine and accessory equipment, and 2½-mile high-pressure steel pipeline from point near Cabin Creek, Pikes Peak district, for increased water supply. Cost close to $470,000, of which $221,405 will be a Federal grant. F O Ray, city engineer, in charge.

(*Continued on Page* 126)

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Calif., Burbank—City will hold election Sept. 23, to vote $350,000 bonds to assist in financing construction of steam power electric generating plant. Additional funds are expected to be $408,000 from W.P.A. and $150,000 from Cities Pub. Serv. Dpt. reserves. Total cost $908,000. J. H. Cambridge, City Hall, plant supt.

Ill., Bushnell—City, G. L. Porter, mayor, soon takes bids constructing municipal light and power plant improvements, incl. distribution lines, street lighting, etc. P.W.A. Warren & Van Praag, Inc., Milliken Bldg., Decatur, engrs.

Ia., Seymour—Bids Oct. 4, by Town, P. West, clk., improving municipal light plant, incl. diesel engine generator and auxiliary equipment. $25,000. R. W. Gearhart, 349 Twenty-First St. S.E., Cedar Rapids, engr.

Ia., Sibley—City plans constructing addition to power plant. $150,909. P.W.A. grant $67,909 and loan $83,000 approved. Burlingame, Hitchcock & Estabrook, Minneapolis, Minn., engrs.

Ia., Stuart—Bids Sept. 30, by City, W. L. Lee, clk., for light plant improvements, incl. two diesel generating units, not less than 300 BHP., removing 2 old generating units which shall become property of contractor. $50,000. H. S. Nixon, Grain Exch. Bldg., Omaha, Neb., engr.

Kan., Neodesha—City plans constructing light plant improvements, incl. 1,500 hp. turbine and plant building improvements. $188,320. P.W.A. grant $84,744 approved. Black & Veatch, 4706 Bway., Kansas City, Mo., engrs.

Mich., Holland—City sketches by Hamilton & Weeber, 1440 Mackinaw Rd. S.E., Grand Rapids, constructing new electric light and power plant, incl. 15,000 kw. generator. $1,500,000. P.W.A. project.

Mich., Mt. Pleasant—City plans by Ayres, Lewis, Norris & May, 506 Wolverine Bldg., Ann Arbor, constructing brick, steel, rein.-con. electric plant. $484,000. P.W.A. project.

Mich., Newberry—Bids Sept. 13, by H. D. Smith, state budget dir., Lansing, furnishing, erecting mechanical and electrical work and equipment for power house at State Hospital, incl. turbo-generator, boilers, stokers, chimney, pumps, heaters, piping, valves, coal and ash handling equipment, for Newberry State Hospital. P.W.A. project. E. R. Little Co., 1801 Ford Bldg., Detroit, engr.

Mich., Wahjamego—Bids Sept. 20, by H. D. Smith, state budget dir., Lansing, constructing 2 story, brick, steel, concrete power house and distributing system. Mechanical work includes turbo-generators, boilers, stokers, pumps, valves, coal and ash handling equipment, electric crane, tunnel and tunnel piping, $325,000. P.W.A. project. E. R. Little Co., 1801 Ford Bldg., Detroit, engrs.

Minn., Alexandria—City plans generator for power plant. $162,465. P.W.A. allotted $73,100 grant. Burlingame, Hitchcock & Estabrook, 521 Sexton Bldg., Minneapolis, engrs.

Minn., Canby—Union Public Service Corp. soon takes bids constructing new power plant boiler, and brick, steel addition to power plant, etc. $150,000. R. D. Thomas & Associates, 1200 2nd Ave. S., Minneapolis, engrs.

Minn., Stewartville—City, G. W. Ellison, clk., surveys ordered for constructing power house, electric generating equipment and distribution system. $120,000. Burlingame, Hitchcock & Estabrook, 521 Sexton Bldg., Minneapolis, engrs.

Minn., Winthrop—City plans constructing municipal heating plant, $108,386. P.W.A. allotted $48,773 grant. Rose & Harris, Inc., 416 Essex Bldg., Minneapolis, engrs. Noted Apr. 28, CD.

Mo., Columbia—Bids Sept. 29, by City constructing power plant and building and repairing old building. $1,085,000. P.W.A. funds allotted. W. B. Cauthorn, Columbia, engr.

Mo., Lamar—City plans constructing light plant improvements, incl. new engine, Diesel type, and addition to building, $150,000. E. T. Archer & Co., 609 New England Bldg., Kansas City, Mo., engrs.

Mo., Odessa—City making plans constructing new power plant, and distribution system. $140,000. Bonds voted. E. T. Archer & Co., 609 New England Bldg., Kansas City, Mo., engrs.

Mo., Vandalia—City making plans constructing power plant and distribution system. $165,000. P.W.A. allotted $74,250 grant. W. A. Fuller Co., 2916 Shenandoah St., St. Louis, Mo., engrs.

Neb., Lincoln—City plans constructing power plant improvements, $175,000. P.W.A. grant $78,500 allotted. D. L. Erickson, city engr. Black & Veatch, 2706 Bway, Kansas City, Mo., consult. engrs.

Neb., Plainview—City, T. W. Culbertson, mayor, plans constructing municipal light and power plant and equipment, etc. $60,000. Buell and Winter, Insurance Exchange Bldg., Sioux City, engr.

N. J., Lakeland—Bd. Freeholders Camden Co., F. W. George, clk., Court House, Camden, plans constructing new brick, steel, concrete central power plant at Mental Hospital. $336,221. Perring & Remington, 509 Cooper St., Camden, engrs.

N. J., Toms River—Twp. Dover, Toms River, will hold election in November to vote on proposal to erect $500,000 municipally owned and operated electric light and power plant.

N. J., Vineland—Boro, Boro Hall, soon takes bids improvements, removing all boilers and replacement with 800 hp. boilers and all auxiliaries, remodeling power plant building, extending deep well pump house and installing therein new motive power house station. $200,000. P.W.A. project. Schofield Eng. Co., Coml. Trust Bldg., Phila., Pa. engrs.

N. Y., Bath—Municipal Comn. plans constructing municipal lighting plant, gas driven engines and generators. Est. $100,000 plus. Fretts, Tallamy & Senior, 5488 Main St., Williamsville, engrs.

N. Y., Oswego—Niagara Hudson Power Corp., 15 Broad St., New York, bids in about two months for constructing steam plant, marine and dock work, transmission lines and equipment in West Harbor, here. Est. $7,250,000.

N. Y., Yonkers—Yonkers Electric Light & Power Co. and Westchester Lighting Co., Yonkers, plan further expansion of power house on Point St. To exceed $100,000. Funds appropriated to include improvements to distribution system.

N. C., Greenville—City, M. Swartz, supt. Water & Light Plant, plans improving power plant, incl. additional boiler, 1 turbo-generator, fuel handling equipment, foundations, etc. $363,680. P.W.A. allotted $163,656 grant. W. C. Olsen, 5 Exchange Pl., Raleigh, engr.

N. D., Valley City—City, L. T. Halverson, aud., plans improving municipal electric light and power plant, building changes, foundations, boiler and equipment, auxiliaries, piping, etc., stack, electrical construction. $161,750. P.W.A. alloted $72,787 grant. Burlingame, Hitchcock & Estabrook, 521 Sexton Bldg., Minneapolis, Minn., engrs.

O., Shelby—City plans constructing light plant $200,000. P.W.A. grant $90,000 approved. J. P. Adkins, city engr.

Okla., Duncan—City election Sept. 28, to vote bonds for extending present municipal light-plant. Final plans in progress. $150,000. V. V. Long & Co., Colcord Bldg., Oklahoma City, engrs.

Okla., Drumright—City will hold election Sept. 28, to vote bonds for constructing municipal light plant and electric distribution system. $280,000. W. C. Austin, Cushing, engr.

Okla., Okmulgee—City sketches made constructing municipal power plant and electric distribution system throughout city. $406,800. W. Wheatley, Okmulgee, engr.

Okla., Pryor—Grand River Dam Authority, Vinita, made preliminary plans constructing additional dam and power plant across Grand River. $4,500,000. Holway & Neuffer, 302 East 18th St., Tulsa, engrs.

Ore., Salem—State Capitol Reconstruction Comn., A. J. Bassett, secy., takes bids within 30 days constructing central heating plant for group of state buildings. $114,130. P.W.A. approves $51,361. Whitehouse & Church Ry. Exch. Bldg., Portland, archts.

Pa., Sharpsburg—City, H. J. Hanman, clk., preliminary sketches completed constructing municipal water and light plant improvements, incl. generating equipment and super heat piping. $145,950. P. Loftus, Oliver Bldg., Pittsburgh, engr.

Tex., Austin—City, c/o G. Morgan, mgr., making plans improvements to waterworks and power plant. $320,000. P.W.A. allotted $157,000 grant. W. E. Seaholm, Austin, engr.

Tex., Texarkana—City, c/o W. V. Brown, mayor, plans constructing electric power plant. $535,000. P.W.A. allotted loan and grant. J. E. Ward, Harvey Snider Bldg., Wichita Falls, engr.

Va., Lexington—Town, c/o H. B. Rice, town mgr., plans constructing electric power plant and distribution system. $366,000. P.W.A. allotted $164,700 grant. Wiley & Wilson, Lynchburg, engrs.

Va., Richmond—Virginia Electric & Power Co., 7th and Franklin Sts., plans constructing addition to 12th St. plant. $3,000,000.

B. C., Brilliant—West Kootenay Power & Light Co., Ltd., Trail, making plans constructing power plant. $5,000,000. Site purchased. L. Campbell, c/o owner, archt. Owner's staff of engineers.

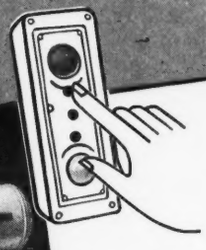
Alaska, College—University of Alaska, C. E. Bunnell, pres., Petersburg, soon takes bids constructing power plant building with complete ramp, incl. boiler, generator, motor generator set, and necessary power plant equipment. $60,700. P.W.A. approved $27,315 grant.

Anything that flows

C-H VALVE CONTROL UNITS START, STOP, MIX, REGULATE . . . AUTOMATICALLY

No matter what you handle in your plant—if it's gaseous, liquid or the consistency of grain or sand, Cutler-Hammer Motorized Valve Control Units can save time and money, speed processes, and give far better results—for example, in the case of chemical processing where accuracy and precision of control are at a premium.

Cutler-Hammer Valve Control Units are available for any *size* of valve from ¾" up . . . for any type of valve from butterfly to the armor plated monsters that handle steam at 2000 pounds. It is difficult to picture briefly their enormous engineering superiority, but there are certain tests you should know about before you select valve control. And in the Cutler-Hammer line there is such breadth of variety as to make positive you get what you need. This is another outstanding contribution of Cutler-Hammer to the progressive betterment of industry. Cutler-Hammer, Inc., *Pioneer Electrical Manufacturers*, 1209 St. Paul Avenue, Milwaukee, Wisconsin.



At the touch of a finger, the sequence carries on. No need to stand and watch, no need for constant supervision. C-H Valve Control Units are a tremendous stride forward toward precision plant operation.

CUTLER-HAMMER

VALVE CONTROL

C-H

ANOTHER CUTLER-HAMMER CONTRIBUTION TO BETTER LIVING

Practical Aids to Operation

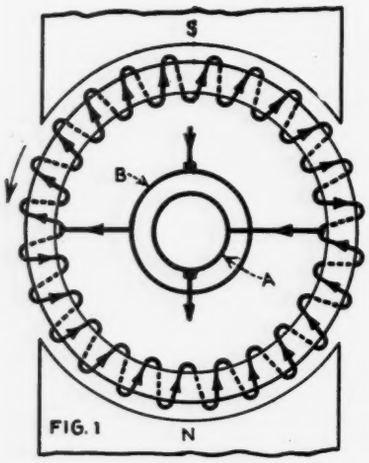


FIG. 1

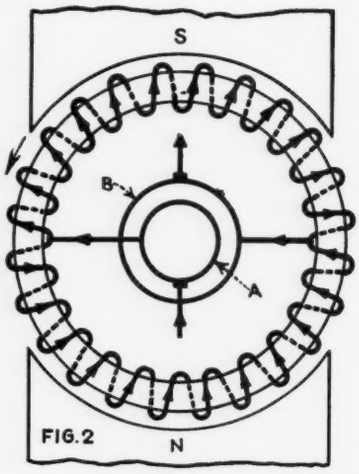


FIG. 2

Solving Unequal Collector-Ring Wear

TROUBLE has occasionally been experienced with unequal wear on collector rings of rotary converters, particularly in the older designs. This in many cases has been caused by arrangement of the brushes on the commutator and can be understood by referring to Figs. 1 and 2. Both figures show the armature in position of maximum current at unity power factor.

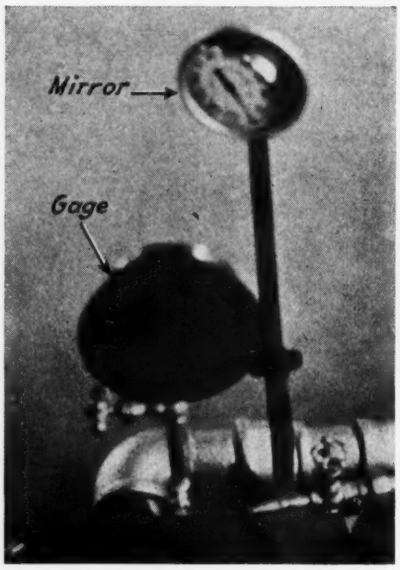
In Fig. 1 current flows from ring *A* to the brush and from the brush to ring *B*. Because of a socalled electrolytic action, there is a tendency to carry copper from ring *A* to its brush and to deposit carbon from the brush onto ring *B*. This action tends to decompose ring *A*; depositing carbon from the brush onto ring *B* can do little harm and the section of the ring under the brush will take on a dark polish.

When the armature turns one-half revolution to position Fig. 2, maximum current flows from ring *B* into its brush and the ring tends to take on a raw appearance. On ring *A*, current flow is from the brush to the ring and this ring will tend to polish.

From this it is seen that one half of each ring tends to polish and wear only a small amount, but the other half tends to develop a raw condition, an action that causes rapid wear. Thus, the rings may wear unequally around their surfaces if the brushes are concentrated on a small area of each.

This conditon can be prevented by distributing the brushes around the rings. For example, if another brush were added on each ring 180 deg from the ones shown, action of the current in each half of the rings tends to equalize. In one position of maximum current deposition, current flow will be from ring to brush at two points 180 deg apart. On the other position, deposition will be from brushes to ring at points 180 deg apart. When the armature has made one-half revolution this action will be reversed, to give equal wear.

Newark, N. J. A R JOHNSON



Mirror Aids Pump Regulation

A PRESSURE gage on a pump supplying cooling water to a 400-hp gas engine was set so as to be visible from the engineer's office. However, this arrangement was of no help to the operator on the engine platform to regulate flow of cooling water through the jacket-distribution line. Since it was not desirable to build up water pressure within the jacket above a specified limit, because of possible leakage into the crankcase, it was necessary for the operator to adjust water flow at what he thought correct, then to walk around to where he could read the gage.

This problem was solved by mounting an ordinary truck rear mirror on the pump foundation. In this location, it reflected the gage reading to the man on the engine platform, as in the figure. Even though the gage hand seems to travel in the wrong direction with pressure changes, it is possible to note the dial figures and to maintain the desired pressure. To make the gage more easily read, figures indicating maximum allowable pressure were gone over with red ink.

Longview, Texas M T PATE

Don't Neglect Safety Valves

A SOMEWHAT amusing but very dangerous incident that occurred recently emphasizes the necessity for safety-valve maintenance. It happened in the boiler house of a large paper mill where a number of boilers are set in battery. The boilers are fired by automatic stokers, and are operated by a group of firemen of a nationality predominating in that particular section of the country. These firemen are skilled, but become excitable under stress of emergency.

One of the boilers was being fired up, preparatory to cutting it in on the line. The safety valves were set at 150 lb and header pressure was maintained at 145 lb. In performing the various duties and activities around the plant, the firemen neglected to observe the pressure gage on the incoming boiler for a time. When they did finally look at, a pressure of 165 lb was indicated. An excited conference was hurriedly held.

Meantime, in the excitement, no one checked the draft or stoker speed. During the few moments of trying to decide what was wrong and what to do, the pressure gage crept up to 175 lb. Alarm and excitement increased when one operator ran to the pressure gage and blew out the test connection, after which the gage went up to 180 lb. It was reported that the boiler began to vibrate on its setting—a statement never checked for possible cause. At any rate, no one dared to approach the boiler and when one

98 YARWAY IMPULSE TRAPS at

LEE of Conshohocken Tires

Yarway Trap and Strainer installed on Rubber Calender. This ½-inch Yarway Trap (weight 18 oz.), will discharge 1290 lbs. of condensate per hour at 100 lbs. W.S.P., and eliminates air binding.

When you ride on Lee Tires—think of the 98 Yarway Impulse Steam Traps on vulcanizers, presses, calenders, heaters, etc., that help to make these great tires.

Yarway Traps are the biggest little thing in profitable operation of steam equipment of all kinds because their quicker heating and greater sustained heating efficiency speed production and save fuel. And when you consider that their purchase is usually no more than the cost of repairing an ordinary trap—why not get Yarway performance for *your* money?

Install a Yarway Impulse Trap or two and let them prove what they can do for you. See how its small size saves space. How its light weight and straight through piping make installation easy. How its unique design, with only one moving part, and its rugged bar-stock construction, cuts maintenance costs. Then too, there is no need to change valve or seat for widely varying pressures.

A nearby Mill Supply Dealer handles Yarway Traps and will be glad to serve you. Or write for Catalog T-1733.

YARNALL-WARING COMPANY, 100 Mermaid Avenue, Phila.

YARWAY IMPULSE STEAM TRAP

helper made a da h for the door, he was followed by the entire crew, who did not stop running until they were on a hill about 1000 ft from the boiler plant.

A few moments after this hurried exodus, the safety valve opened with a roar, and blew for about five minutes. The chief engineer, who was eating his lunch at home nearby, heard the commotion and hurried to the deserted plant, followed shortly by the scared operators. The pressure had blown back to normal, but the chief, after hearing the story, ordered the boiler removed from service to check for damage and test safety-valve operation.

It was learned that the safety valve on this boiler had not been tested, nor had it blown for several months. Dust and moisture had caused a gummy deposit to pack around the spindle, and to harden in a solid mass. As a result, the valve failed to open until an excessive pressure had broken the deposits.

Chicago, Ill. C A ARMSTRONG

Operating Pressure for Regulators

TO SECURE highest accuracy of control, constant pressure should be maintained at the pilot valves of regulators having water-actuated cylinders. In one large plant, this was considered so important that a separate pump having a pressure governor was installed to supply water to a separate piping system feeding a number of these regulators.

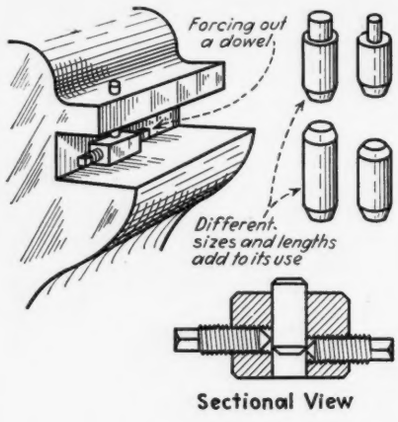
The pump takes its suction from the station raw-water supply. The piping is arranged so that if the pump fails, pressure on this line will open a check valve to prevent loss of pressure in the regulators.

Lynchburg, Va. O M ROBERTS

Close-Quarters Forcing Jack

ONE of the handiest tools I have in my tool kit is a simple forcing jack, made from a good grade of tool steel and tempered to give life and strength. I used 1.5-x-1-in. steel drilled for a 0.5-in. drill-rod plunger and 0.5-in. tool steel screws having 20 threads per inch.

Ends of the screws are conical pointed to bear under the chamfer-plunger end. Using two screws gives a plunger travel of 0.5 in. In use, the lower screw turns in first and then the upper one is brought into use when the first has raised the plunger. This little tool will be found useful



for setting up shop machines and as a forcing plunger to push out pins and bushings in close quarters. Plungers of various lengths and top diameter can be used to extend the application of the jack.

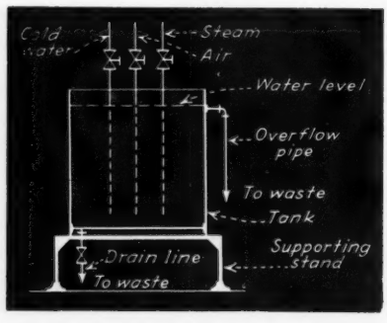
Penacook, N. H. C H WILLEY

Checking Thermometers, Temperature Controllers

IT HAS been said that inaccurate instruments can be more misleading than no instruments at all. This statement is particularly true of thermometers and temperature controllers used in power service operation and distribution, where very slight errors in calibration may upset the heat balance and increase over-all costs. Fortunately, in most of these applications, accuracy is important over a very narrow portion of the total scale range and the temperature-sensitive device can be readily checked while in service, by comparing its indications with the readings of a previously calibrated test thermometer placed in a well adjacent to the bulb of the instrument.

Where test wells are not installed or where accuracy is desirable at a number of widely separated points on the scale range, the temperature-sensitive element must be removed from its permanent location, and both it and the test thermometer immersed in a fluid having the desired temperature.

In one large plant, tanks, as in the figure, arranged so that fluid temperatures can be varied at will, are used



to check instruments with scale ranges above the freezing point. By properly manipulating steam and water valves, temperatures above the inlet-water temperature can be obtained at will. The air line agitates the liquid and prevents stratification into layers of different temperature. Ice must be added when temperatures between 32 F and the inlet-water temperature are desired.

For instruments with ranges up to 500 F, a tank with an immersion-type electrical heater, a mechanical means of agitation, and filled with cylinder oil or some form of vegetable shortening is used. Instruments reading below 32 or above 500 F are sent to the plant laboratory and checked by the chemical staff who use standard methods that can be found in any chemical-engineering handbook.

When bulbs and test thermometers are placed in the checking tanks, care must be taken to see that the proper immersion point is reached and not exceeded. Unless a very high degree of accuracy, beyond every day requirements, is desired, steam corrections can be dispensed with, providing the emergent section is very near room temperature. Covers placed just over the liquid level in the tanks will prevent rising currents of heated air or vapors from overheating the stems.

Roanoke, Va. S H COLEMAN

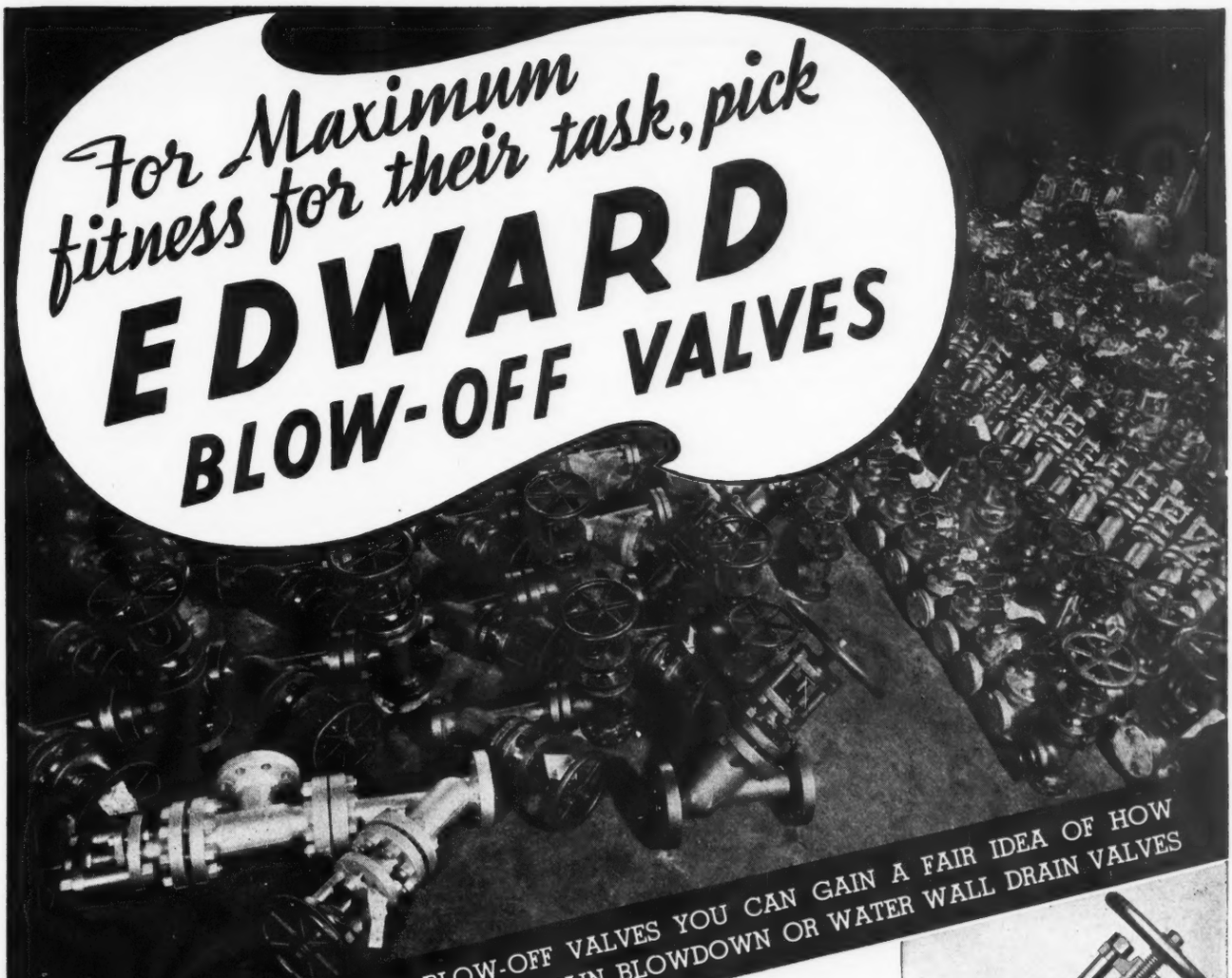
Repairing Holes in Switchboard Panels

HOLES exposed by the permanent removal of apparatus seriously affect the appearance of switchboard panels. If the panel is polished marble, holes can be patched with sealing wax, taking care to select colors that match the surrounding surfaces. Openings in black marine-finish marble or slate can be neatly plugged with a cement composed of litharge, lamp black and glycerine. This cement can be made by thoroughly mixing 1 pint of litharge and 0.25 pint of lamp black sieved through a 50-mesh screen. To 3 pints of the screened powder add 1 part of glycerine (by weight) and mix into a smooth paste. This paste sets up rapidly and no more than is required for a particular job should be mixed at one time. Fill the hole with the paste, trowel it in firmly, and leave $\frac{1}{8}$ in. excess above the panel surface to compensate for shrinkage.

Allow the cement to dry at least 12 hours and then rub down to the level of the panel with a soft rubbing brick without marring surrounding surfaces. Then spray repeatedly with lacquer and rub down with fine sandpaper or

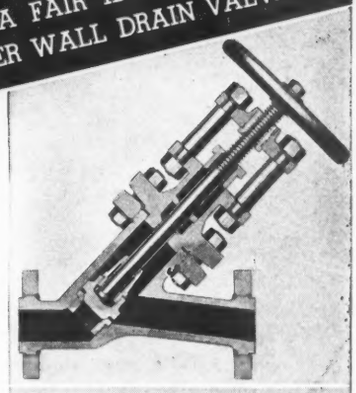
For Maximum fitness for their task, pick

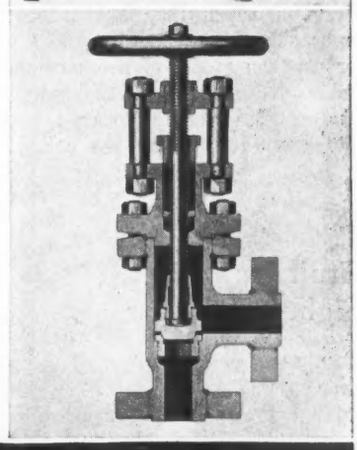
EDWARD BLOW-OFF VALVES



FROM THIS LOT OF EDWARD BLOW-OFF VALVES YOU CAN GAIN A FAIR IDEA OF HOW MODERN BOILERS ARE TRIMMED AS TO MAIN BLOWDOWN OR WATER WALL DRAIN VALVES

Complete elimination of non-essentials — accuracy in selecting and testing materials—rigid adherence to best machining practice—mark the 1938 Edward blow-off valves.





BLOW-OFF valve choice is increasingly Edward. Check up the new boilers—modernized industrial steam generators—top pressure utility units—superimposition, renovation and rehabilitation projects—and you will find Edward staunchly standing up to its task.

Simplicity—maximum fitness for their work—mark the design details of the new Edward blow-off valves. Two basic types and four pressure classes meet every piping option. Study the Edward catalog 11-D. Pick Edward for the next job, be it repair, modernization or a new boiler unit.

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EDWARD VALVES

Stop · Check · Blow-off · Non-return · Feed Line · Relief · Bleeder Line · etc.

emery cloth until a neat appearance is obtained.

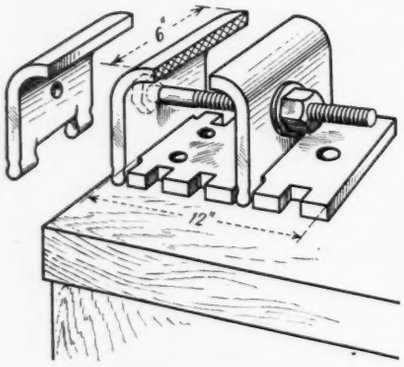
While it is possible to close holes in metal panels by soldering or welding in filler pieces and then refinishing the surface, this method is ordinarily impractical. Heat required to do the job may warp the panel, permanently damage its finish, or injure adjacent wiring and equipment. The best method is to close the openings with special metal buttons obtainable from the manufacturer of the panel. Though not flush with the panel these buttons have the same finish and make a very satisfactory appearance.

Lynchburg, Va. O M ROBERTS

A Wide-Opening Clamp Vise

FOR securely holding bulky jobs while filing, scraping fitting, etc, there is a need of a wide-range vise or clamping device. The simple plate-steel clamp vise, in the figure, has served this purpose well.

The clamp is made in three sec-



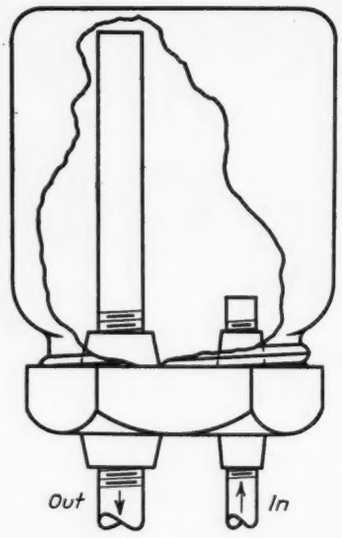
tions: two jaws alike, and the notched base on which they are spaced and operated. It can be secured to a bench or used on any drill press or milling table. Adjustment of the jaws is a matter of using the nearest suitable notch and tightening the bolt.

Boston, Mass. L W ROGERS

Fruit Jar Makes Sight Oil Feeder

ONE DAY, while in a small steam-engine plant, I noticed the sight-feed on a cylinder lubricator as shown in the figure. It was made of an ordinary pint fruit jar with a brass screw cover having one boss for an $\frac{1}{8}$-in. inlet pipe and one for a $\frac{1}{4}$-in. outlet pipe.

Oil was pumped by a plunger pump driven from the engine shaft by belt and gearing. At that time the glass



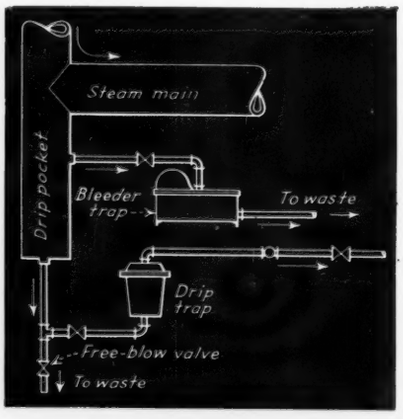
jar had stood the 60-lb steam pressure, at which the plant operated, for 2 years. I don't know what the factor of safety in the glass was, but it probably was well down into the danger zone.

New York, N. Y. C W PETERS

Automatic Bleeder Trap Prevents Water Hammer

ECONOMICAL management of steam-distribution systems serving building-heating or intermittently scheduled process loads often necessitates turning steam on and off at frequent intervals. With this method of operation, service conditions are severe because of expansion and contraction strains and water hammer. These factors should be given consideration when designing the piping and adequate provision for expansion and drainage provided.

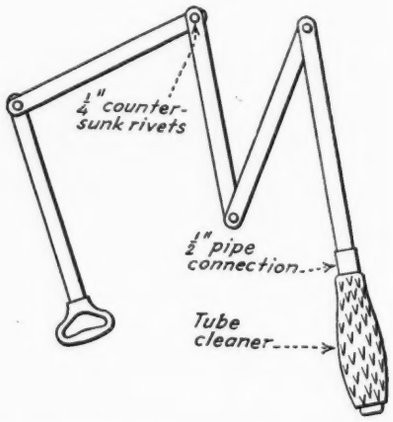
A common error is to install traps at low points in the system without



making provision for drainage when shutting down or warming up. Traps will only function when a differential pressure exists across their orifices. Unless the trap discharges directly to atmosphere, it must discharge against the backpressure ordinarily present in most condensation-return piping. Whenever pressure on the steam line drops below this backpressure, some other method of removing the condensation must be used. Free-blow valves in the drip connection just ahead of the trap are usually installed for this purpose. These valves are opened when the system is shut down and left in this position until pressure is again built up to where the trap functions properly. Operating free-blow valves involves the human element.

Where conditions justify, automatic bleeding devices should also be provided to guard against the possible consequences of carelessness. Such a bleeder, installed in a large institutional heating system, is shown in the figure. In this installation, a float trap is connected to the central drip of the steam main well above the regular drip trap. When the regular trap stops working, water overflows through the bleeder trap to an open drain. A vacuum breaker on the steam main speeds up equalization of pressures when the steam is shut off.

Richmond, Va. C R ANDREWS



Extension for Tube Cleaner

IN AN ice and cold-storage plant installed three years ago, I found the vertical shell-and-tube condenser reaching to within 30 in. of the ceiling, without a trapdoor above for tube cleaning. A beam, the weir and cooling tower directly overhead prevented cutting a trapdoor.

The tubes were cleaned by screwing on sections of $\frac{1}{2}$-in. pipe, until the operator designed the extension shown in the figure. Needless to say, he remembered his 6-ft rule. The cleaner occupies little space and can be hung on the wall beside the condenser or folded and placed in the toolbox.

Marissa, Ill. GEORGE BLUM

HOW MUCH

can good feedwater treatment save?

HOW much you can save by adopting the Nalco System of Feedwater Treatment depends on the condition of your water, your boilers, etc. For an accurate estimate, we suggest that you have us make a survey in your plant. This involves no cost or obligation on your part. Drop us a line today. NATIONAL ALUMINATE CORPORATION, 6222 W. 66th Place, Chicago, Ill.

$3,396.00

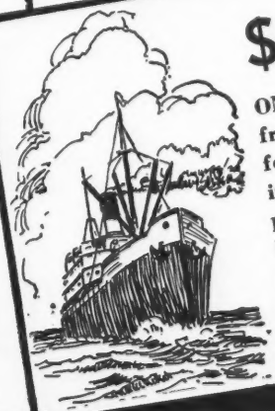
IN THE first eleven months of operation in an 800 h.p. mid-western power plant, the Nalco System was credited with savings totaling $3,396. The figures showed $2,291 less coal burned . . . cost of chemicals reduced $372 . . . boiler cleaning costs $722 lower.

$42,918.00

A RAILROAD company standardized on Nalco for all of its locomotives. This involved treatment for water from 52 different stations. After allowing for differences in mileage, the net savings for maintenance and washing costs alone, in one year amounted to $42,918.00.

$7,666.00

ONE OF the major oil companies recently ran a test on the cost of drilling two comparable wells. Savings in fuel, water, washouts, and repairs for the outfit using Nalco totalled $7,666.00.



$1,537.50

ON THE Great Lakes, a freighter was given Nalco feedwater treatment. Soon, it was averaging fifteen pounds less coal per mile. During the season, the boat covered 41,000 miles and with coal costing $5 per ton the saving was $1,537.50.

ANY WATER **NALCO SYSTEM** ANY PRESSURE

Inquiries other than domestic, *except those from U. S. Possessions, Canada and Mexico,* should be addressed to ALFLOC LTD., Bush House, Aldwych, London, W. C. 2, Eng. Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay St., Toronto, Ont.

Readers' Problems

Questions for Our Readers

Water Hammer

Question 1

BURSTING *of several lead bends during the past few months has called attention to what seems to be excess pressure created by the quick closing of an automatically operated valve on a washing machine. Water-main size is 8 in., and pressure is 100-150 lb. Laundry supply is taken directly from main, reduced to 55 lb, and piped to the washing machine. An air chamber inserted on the low-pressure side of the reducing valve consists of a 4-in. pipe, 48 in. long. Water is drawn through the automatic valve, which closes suddenly when the proper level has been reached in the machine. The amount of water drawn varies from 50 to 200 gal.*

The question is, does the sudden closing of the automatic valve create an excess pressure sufficiently high to burst a ¾-in. lead bend, which is taken off the main 300 ft from the laundry. If so, how can we overcome this difficulty?—FJG

Ammonia in Brine

Question 2

IT LOOKS *as if one of our brine tanks has a slight ammonia leak. Is there a way to determine the exact amount of ammonia present in the brine as a result of this leak? A 2-oz sample taken from the tank will turn pink when 3 drops of phenolphthalein test solution is added*—LMB

Suitable answers from readers will be paid for if space is available for publication.

Keeping Boilers Clean

Answers to August Question 1

The Question

OUR FEEDWATER *contains 25 ppm silica, 10 ppm iron, and 51 ppm of non-incrusting solids. Can some* POWER *reader tell me if phosphate will keep our boilers clean? If so, should I use trisodium or disodium phosphate? How do I arrive at the amount to use?*—JDO'N

Not One Problem—Dozens

JDO'N's question deals with not one problem but dozens. Pressures, temperatures, capacities, blowdown, and their changes, are only a few of the factors involved. In the first place, from the amount of silica present it would seem that at least part of the non-encrusting solids must be alkaline. Silica is so insoluble except under alkaline conditions, that the amount present would indicate that caustic embrittlement should be considered.

Phosphate will remove the iron, and the kind to use depends on the alkalinity of the feedwater. If this is low, trisodium fits, but if pH is 7 or over, disodium phosphate should be used. Chlorine content is also important, particularly if boiler pressure is above 450 lb. For these pressures it seems advisable to carry the iron and aluminum oxides above 0.6 times the silica. Therefore it may be more important to consider the silica instead of the iron. For lower pressures the silica also seems to aid the caustic action on steel.

Evaporation of feedwater introduces the question of concentrations. Introducing chemicals directly into the feedwater requires intelligent application. While it fell into bad repute on account of some cases of abuse, it is to be recommended under many conditions.

So many questions arise that my advice is to call in someone familiar with boiler-water conditioning. and go over the entire set up. It may bring suggestions that will save many dollars.

Lakewood, Ohio J P SIMONS

Chemist Needed

THE ONLY safe way to arrive at the kind and amount of material to use for any boiler-water treatment is to secure the services of someone who knows how (1) to analyze all of the conditions involved, and (2) to recommend a simple procedure for controlling the dosage by means of periodic tests to determine the conditions of water in the boiler.

It may be that phosphate would be an important constituent of the prescription needed in this case, but it would be dangerous to accept any recommendation not based on more details than are given in the question. Some plants have had expensive experience with deposits of phosphate unwisely applied.

The best procedure is to engage a competent professional chemist specializing in water-treatment problems, one who is not interested in selling any particular product. You can rely on him to determine just what combination of materials your boiler water needs, and to tell you how to apply them for best results. Total cost of materials and service will probably be less than for any other method of solving the problem.

Springfield, Ill. K M HOLADAY

How About Calcium and Magnesium?

WHEN JDO'N gave the feedwater analysis he didn't mention whether calcium or magnesium was present. Nearly all waters containing silica have one or both of the others. Recent experiments show that the presence of silicon with caustic hydroxide is the chief cause of embrittlement. Also it has been demonstrated that silicates of magnesium and calcium form the hardest of scales.

Ordinarily phosphate is used to inhibit if not prohibit the formation of calcium or magnesium scales. Unlike the so-called sulphate ratio, the use of phosphate is based on definite chemical combinations. When sodium phosphate (mono, di, or tri) dissolves, both sodium and phosphate ions are formed. Whenever a phosphate ion and calcium or magnesium become associated, a relatively insoluble sludge is formed. The calcium or magnesium so "bound" does not become released to form silicates.

Enough phosphate must be in solution to assure a union with calcium. The average of various authorities places the concentration at 40-50 ppm. About 1½ lb of phosphate (tri-soda) is required for every lb of calcium carbonate in the feedwater. If continuous blowdown is employed an additional amount must be added to equal that which is lost in blowdown.

If a pure silica scale is being formed, it is doubtful if addition of phosphate will be of benefit. However, if calcium or magnesium is present at all, the treatment should prove helpful. A high-grade sodium phosphate can be obtained at from 10 to 15 cents per lb. A solution of one lb to 3 or 4 gal. of water can be fed to suction of a pump or to hotwell without expensive dispensing

MANY STATES have adopted boiler codes based, in most cases, on the ASME Boiler Construction Code. By formulating experience and known facts, these codes promote safe boiler-plant operation. They will work most effectively if they are understood as well as followed. Printed below is a paragraph from the ASME Code. Read it, and consider the reasons for the rule. Then turn to page 116 and check your thinking with the discussion given there.

SAFETY-VALVE MUFFLERS

P-279: "If a muffler is used on a safety valve, it shall have sufficient outlet area to prevent backpressure from interfering with the proper operation and discharge capacity of the valve. The muffler plates or other devices shall be so constructed as to avoid any possibility of restriction of the steam passages due to deposit."

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IMPORTANT NEWS FOR ENGINE AND COMPRESSOR BUILDERS AND OPERATORS

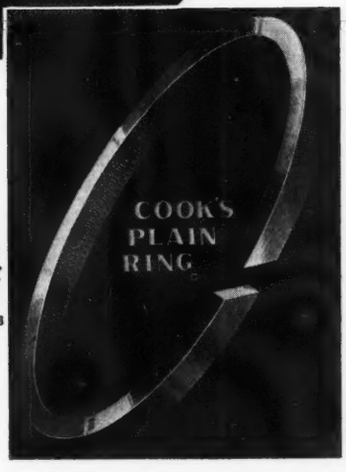
NON-SCUFF — DOUBLE-QUICK SEATING — PISTON RINGS... THEY'RE *Tinized!*

A new development—a vital advance in piston rings that brings to builders and operators of industrial size engines and compressors, new standards of performance and economy—**"Tinized" piston rings—rings with a non-scuff anti-friction metal facing that protects cylinders, promotes double-quick seating** and greatly reduces "break-in" running time.

Fully patented, these rings are standard COOK'S GRAPHITIC IRON Piston Rings coated with a tin-base bearing alloy. The **entire** working surface is covered, and the process assures a permanently bonded facing of uniform thickness, without any weakening or alteration of the ring structure.

The addition of this non-scuff facing to COOK'S GRAPHITIC IRON Piston Rings, long famous for their superior sealing and wearing properties, makes available to Equipment Manufacturers a ring that safeguards cylinders during the break-in run on the test floor—and to Operators a ring that preserves the work-hardened skin on cylinders already broken in.

Every engine and compressor builder and operator should know all about COOK'S "TINIZED" PISTON RINGS. Bulletin 385-P gives full details. Write for a copy—today.



SEALING PRESSURES SINCE 1888

50th ANNIVERSARY

C. LEE COOK MANUFACTURING CO.

INCORPORATED

New York Cleveland Los Angeles Baltimore LOUISVILLE, KY. Chicago Tulsa New Orleans San Francisco

TINIZED*

COOK'S GRAPHITIC IRON

*NON-SCUFF—QUICK-SEATING—ANTI-FRICTION METAL FACED

Piston Rings

apparatus and without damage to the feedwater system. The form of phosphate should make little or no difference.

Tucson, Ariz. BILL MADDOCK

Aligning Line Shafting

Answers to August Question 2

The Question

WOULD *some* POWER *readers tell me the best way to align line shafting, especially whether it should be aligned with the belts on or off the pulleys? It seems to me that if it is done with the belts off the pulleys, the increased loading when the belts are put on will cause misalignment. I believe that alignment should be checked under operating conditions, or as close to these conditions as it is practical to go.*—CAA

With Belts On

THE PROPER way to align line shafting is with belts on the pulleys. Furthermore, alignment should simulate actual working conditions as closely as possible. It isn't enough to have belts in place, the belts should be loaded, if possible, to the same extent they would be loaded when pulling their maximum.

Obviously, if shafting is aligned unloaded and without belts, it will be thrown out of alignment as soon as belts are put in place. If then realigned, it will be thrown out again when power is turned on. Thus, aligning should be done under conditions as close to those at full load as is possible. All of which goes to show the difficulty of correct aligning. It is impossible to do a perfect job without having bearings on both sides of every pulley.

Newark, N. J. J H SQUIRES

Belts Should Be Removed

A LINE SHAFT cannot be placed in true alignment until all stress has been removed, such as belts, ropes, gears, etc. When this is done, run a fine steel wire the full length of the shaft at any available position, almost directly underneath the shaft. Support the line about 3 ft from the floor and have it stretched tight by weights over the end of the supports. Drop a plumb line over the shaft at each end and midway along. Set the steel wire in the mean position of the three points.

For perfect accuracy, remove coupling bolts. Measure between the plumb lines dropped at various points and the steel wire. When trued in this manner, the shaft will be in perfect horizontal alignment. For vertical alignment use a machinist's level about 2 ft long, applied to the shaft at various points. If shaft supports have no means of adjustment, then shims must be removed or added to bring to true level.

To check couplings for alignment, test by feelers between surfaces and by turning the shaft around in sections. If couplings are out of line or shaft bent, treatment in the lathe is required. When all is satisfactory, replace coupling bolts, and secure all hangers and supports.

WHY THIS RULE?

SAFETY-VALVE MUFFLERS

SAFETY-VALVE mufflers are commonly used in boiler plants where noise of escaping steam might be a source of annoyance or complaint. Most mufflers discharge the initial jet of steam into a primary chamber, and then allow it to escape therefrom in a large number of secondary jets at low velocity. Thus the initial "pop" is somewhat silenced, and the combined audibility of a number of low-velocity jets is considerably less than one large, high-velocity discharge.

The first part of the rule deals with aggregate area of escape ports. Inadequate area will cause restriction of flow to counterbalance the effect of the "huddling" or "reaction" chamber. The valve will chatter destructively and cause serious mechanical damage in a short time. Unrestricted, free discharge is essential to safe operation of safety-valves.

The area of muffler escape ports is not specified in the rule but it is definitely stated that they shall be large enough to prevent deposits from carryover or other sources restricting the individual discharge areas.

The shaft will now give no trouble due to misalignment, unless caused by one or more of the following: (1) Shaft too light for duty demanded, (2) supports too widely spaced, or insecurely fastened, (3) one or more of the driven pulleys out of line with drivers, and (4) shaft pulleys unbalanced or improperly fitted to shaft.

Kearney, N. J. GEORGE MCNALLY

Use a Transit

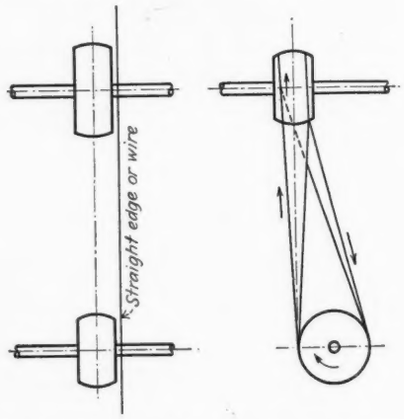
OUR EXPERIENCE indicates that the best way to align shafting is with a transit. In starting off on a long line shaft the first thing we do is set up location of the hangers. This may be determined by transit, or if not available, a wire may be stretched, locating the centers of the hangers on the trusses or supports. Hangers are then placed with the bottom half of the bearings. Line shaft is entered and allowed to rest on half bearings. The shaft itself should then be straightened by adjusting the bearings, using the transit as a guide. If no transit is handy a piano wire (about 16 gage) may be stretched beside the hangers at about shaft level. A spirit level and a gage or steel rule may then be used to straighten the shaft. Bearing caps should not be placed until the shaft is in line.

Lining up can be done much better and easier with no load on the shaft. Hanger spacing and drive arrangement should be studied before the installation is made. Drive and load should be balanced on opposite sides of the shaft as far as possible. Where this arrangement cannot be made, hanger spacing should be such that a hanger is located on each side of the drive pulley. Another hanger should be near each load pulley. Where this practice is followed, no difficulty should be experienced with changed conditions.

Lakewood, Ohio J P SIMONS

Another Vote for Aligning with Belts Off

THERE ARE two general arrangements of line shafting: (1) where all shafts are parallel, and (2) where one shaft is at right angles to the other. Both may be on a horizontal plane, or one shaft may be horizontal and the other vertical. In the first arrangement (see sketch) it is important to have all shafting parallel, and as near level as possible. Keep all belts off the pulleys and align so that centers of all pulley crowns are absolutely opposite to each other. This can be



done with a straight edge if pulleys are close together, or by a chalk line or fine wire drawn tightly past the edges of the pulleys. If pulleys differ in width, use edge of widest pulley for straight edge and measure to crown center of narrower pulley.

Where one shaft is at right angles to another, it is important to have all shafts level on both horizontal and vertical planes. Pulleys have to be placed so that the face of the pulley where the belt leaves it is absolutely opposite to the center of the face where the belt next contacts.

It is always best to align pulleys and shafting with all belts off, for if shafting is properly supported there is no danger of change in alignment. It is easier to change location of pulleys and shafting when belting is out of the way.

Bismarck, N. D. LESLIE BRADLEY

Supports Important

I HAVE FOUND that when hangers are supported by a rigid structure such as steel stringers independent of the ceiling (supported from the ground floor) and when the points of shaft load are close to points of shaft support, that it is simplest to align with belts on but not running. Alignment will hold when running under load. Where the ceiling or floor above which supports the shaft

(*Continued on page* 126)

HAGAN AUTOMATIC COMBUSTION CONTROL

"Thinks" like an engineer

...acts *instantly!*

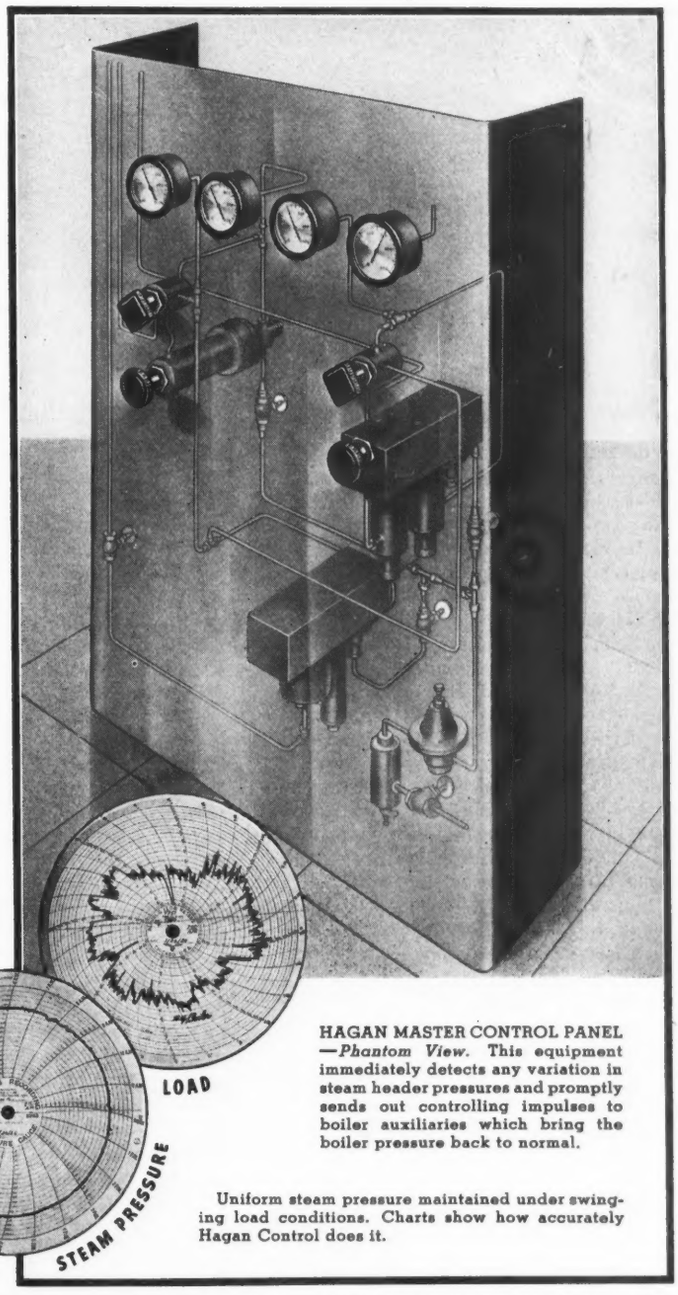
Maintains Uniform Steam Pressure and Top Efficiency at Any Load

WHEN it comes to combustion control, Hagan Automatic Equipment practically does the engineer's thinking for him. It actually detects changes in steam conditions before they become apparent—snaps into action—adjusts fuel and air mixture to the exact amount to maintain proper pressure—keeps the boiler working at highest efficiency.

All these operations are automatic and practically instantaneous. The most competent operator depending on manual equipment would find it impossible to maintain such constantly accurate control. The result is more economical boiler operation, quicker responses to load changes, proper division of the load between boilers, greater safety and utmost reliability.

Hagan, the pioneer and still the leader, designs control for all types and sizes of boilers for any load condition. Call or write us now. Our engineers will gladly study your equipment with an eye to lower operating costs.

THE HAGAN CORPORATION
300 Ross Street Pittsburgh, Pa.



HAGAN MASTER CONTROL PANEL —*Phantom View.* This equipment immediately detects any variation in steam header pressures and promptly sends out controlling impulses to boiler auxiliaries which bring the boiler pressure back to normal.

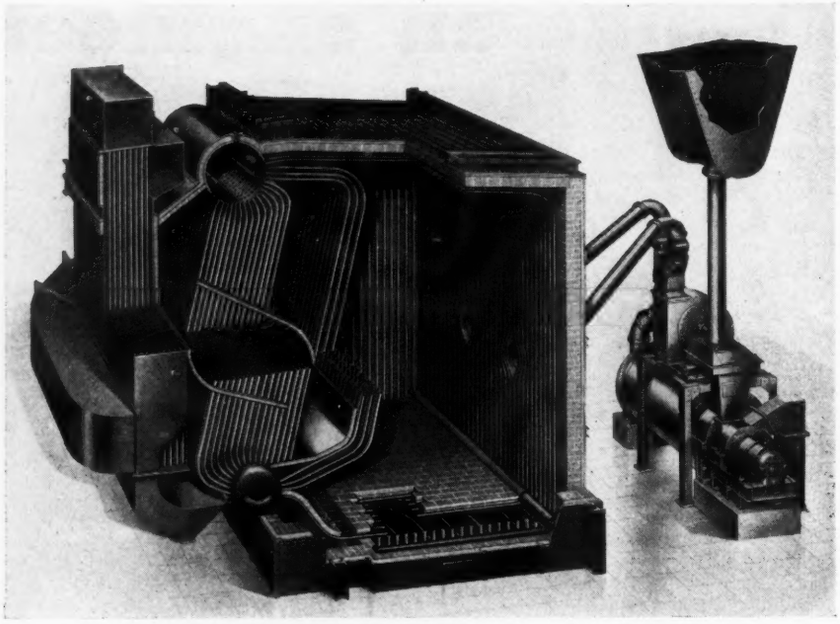
Uniform steam pressure maintained under swinging load conditions. Charts show how accurately Hagan Control does it.

SEND FOR NEW FREE BOOK

Hagan Automatic Combustion Control. The complete story in a beautifully illustrated 20-page brochure. Shows how Hagan Control improves the operation of all types of boilers.

HAGAN *Automatic* COMBUSTION CONTROL
The pioneer . . . and still the leader

What's New in Plant Equipment



Steam Generator

PULVERIZED-COAL-FIRED boiler consists of two drums connected by a system of bent tubes, both boiler and waterwall. The two drums are one above the other with varying distances between horizontal centers and are connected by boiler tubes arranged in semi-vertical position. Waterwall tubes completely enclose furnace on three sides as well as roof and floor, and connect waterwall headers with top steam and water drums. Feeder and floor tubes connect waterwall headers directly with bottom water-storage drum. Under normal conditions, unit is furnished with streamlined monolithic baffles, arranged for cross-flow of gas in three passes across boiler tubes. "Shadow" or reflecting wall, produced by arranging boiler setting 4 in. behind waterwall and arch tubes, is said to make full circumference of tube effective heat-absorption surface.

Kennedy-Van Saun Mfg & Engrg Corp, 2 Park Ave, New York, N. Y.

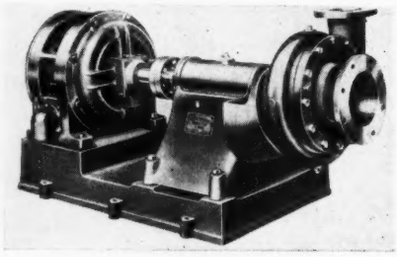
Secondary Fuse

OUTDOOR indicating secondary fuse is for transformer secondary protection or banking, and isolating service-entrance faults. Corrosion-resisting materials are used throughout and fuse link is enclosed in weather-tight housing of Textolite. Internal fuse assembly is held under constant tension by compression spring that exerts outward pressure on retaining collars. Enclosing tube, however, is free from spring pressure, and a strain wire shunted across fusible element relieves it of mechanical stress.

General Electric Co, Schenectady, N. Y.

Centrifugal Pump

TYPE HBD, single-stage, side-suction, vortex centrifugal pump is being built in sizes of 1½ to 18-in. discharge, 10- to 15,000-gpm capacity, and heads up to 300 ft in smaller sizes. Pump casing of solid volute type with removable suction head. Eccentric nozzle on suction head permits removal without disturbing discharge pipe or pump alignment. Enclosed



impeller, cast in one piece, balanced, locked on shaft by key and non-rusting impeller nut. Two heavy-duty, double-row ball bearings, lubricated by an oil reservoir, support the shaft. Bearing nearest pump carries radial load only and is self-aligning. Outer angular-contact bearing carries thrust and radial loads.

Lawrence Pump & Engine Co, P O Box 70, Lawrence, Mass.

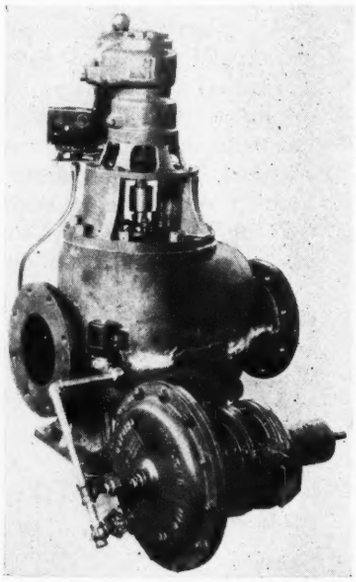
Thermostat

"TWO-STAGE SENSATHERM" has two dust-proof sealed mercury-contact switches, operated by one bimetal coil and two permanent magnets. For room-temperature control on high-low-fire gas or oil burners, for eliminating overshooting temperatures on stokers with forced-circulation warm-air systems, and for regulating 2-speed fans on air-conditioning systems. Bulletin No. B-8.

Mercoid Corp, 4201 Belmont Ave, Chicago, Ill.

Automatic Strainer

SELF-CLEANING automatic unit consists of strainer, operating motor, pressure switch and diaphragm-actuated gate valve in waste-discharge connection. Strainer has cast-iron body inside of which is a cylindrical perforated bronze basket, free to be rotated about its axis and partitioned into a number of sections. Normally, strainer basket is at rest. Water passes through perforated-basket sections to the outlet. Refuse and other solid matter, not being able to pass through perforations, are caught by screen and held or dropped to bottom of basket. As solid matter accumulates in the basket, pressure at strainer outlet drops slightly. When this pressure



drop equals that for which switch is set, switch closes, motor starts, rotating basket, and discharge gate valve opens in waste line. Rotation of basket causes one section after another to be cleaned by flushing with clean water.

The Blackburn-Smith Mfg Co, Inc, 310 12th St, Hoboken, N. J.

Voltmeters

USING same terminal arrangement as standard instruments, new Type AP-9 temperature-compensated voltmeters differ in ohms-per volt sensitivity, temperature coefficient, and accuracy. Two instruments, 150-volt and 150–300-volt; both, when used on 150-volt tap, are ac-

PARTIAL LIST OF ORDERS RECEIVED

FOR THE NEW COPES FLOWMATIC REGULATOR

USER AND LOCATION	DATE	BOILER DATA NO.	MAKE	WSP LB.	MAX. EVAP. LB./HR.
Canadian steel mill	1937	1	Freyn	130	25,000
Canadian steel mill	1938	1	B & W	450	120,000
Connecticut industrial plant	1937	2	Riley	700	90,000
Illinois industrial plant	1937	2	Riley	700	90,000
Kansas utility plant	1938	2	F-W	650	70,000
Maryland textile mill	1937	2	Riley	450	200,000
Michigan chemical plant	1938	1	F-W	1325	300,000
Michigan paper mill	1937	1	Baden.	550	110,000
Michigan rubber company	1937	3	Lasker	450	20,000
Michigan utility plant	1937	1	B & W	850	400,000
Michigan utility plant	1938	1	F-W	875	400,000
Missouri utility plant	1938	1	B & W	225	120,000
and	1938	2	W & W	180	110,000
Nebraska utility plant	1937	3	B & W	400	140,000
Nebraska utility plant	1938	2	C-E	475	200,000
New Jersey industrial plant	1938	1*	C-E	400	50,000
New York brewery	1938	3	C-E	410	75,000
New York industrial plant	1938	1	Baden.	650	100,000
Ohio steel mill	1938	2*	B & W	415	330,000
Ohio textile mill	1937	1	Vogt	150	85,000
Pennsylvania industrial plant	1938	1	Vogt	450	100,000
Pennsylvania paper mill	1937	1	Spgfld.	600	100,000
Pennsylvania steel mill	1938	1*	B & W	400	85,000
Pennsylvania utility plant	1937	1	B & W	675	200,000
Pennsylvania utility plant	1938	1	F-W	875	400,000
Texas chemical plant	1937	1	B & W	400	200,000
Texas oil refinery	1937	1*	Riley	600	350,000
Virginia paper mill	1938	2	B & W	450	120,000

*Two COPES Flowmatic Regulators purchased for each boiler.

Name of any user listed above will be furnished on request.

Why this trend to the new Flowmatic?

There are good reasons why the trend in modern plants is definitely to the new COPES Flowmatic for effective feed water regulation. Closer boiler water level control on the most rapidly swinging loads. Trouble free operation with only routine attention. Simple adjustment. Easy installation. All add up to safer, more economical operation of fast steaming generators. To be sure of these benefits, specify the COPES Flowmatic. Write, on your letterhead, for descriptive Bulletin 409-A.

NORTHERN EQUIPMENT CO., 1011 GROVE DRIVE, ERIE, PA.

Feed Water Regulators, Pump Governors, Differential Valves
Liquid Level Controls, Reducing Valves and Desuperheaters

BRANCH PLANTS IN CANADA, ENGLAND, FRANCE, GERMANY, AUSTRIA AND ITALY . . . . REPRESENTATIVES EVERYWHERE

Get closer boiler water level control with the new

COPES

FEEDS BOILER ACCORDING TO STEAM FLOW•AUTOMATICALLY

FLOWMATIC

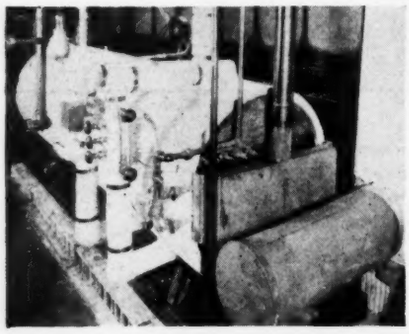
★ REGULATOR

curate to within ½% throughout the 75- to 150-volt portions of their scales. Remainder of scale, in each instrument, maintains standard accuracy of ¾%.

General Electric Co, Schenectady, N.Y.

Gas Boiler

IMMERSION horizontal fire-tube gas boiler is automatic and continuous in operation. Tubes are under water for their entire length. Heat is supplied through a series of tubes making two complete passes each and giving 14 ft of flue-gas travel each. 8-in. space is between boiler bottom and lowest tubes for collecting sediment, which can be removed by blowdown. Firing is by a battery of specially constructed immersion gas burners, each of which fires into the end of one tube. The first pass of tubes is in the upper portion of the boiler and the return in the lower. As the hottest portion of these tubes is just

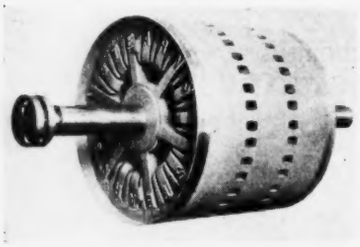


below the water level, steam is generated quickly while water in the bottom is receiving quick preheat from waste products of combustion.

Sellers Engrg Co, 2145 N Ashland Ave, Chicago, Ill.

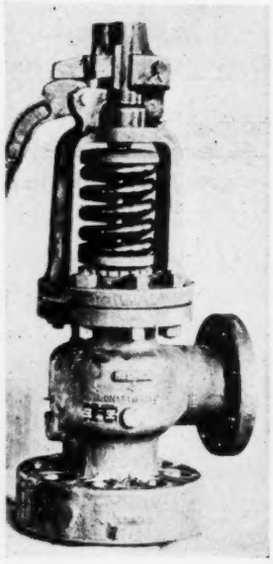
Magnetic Pulley

IMPROVED high-duty magnetic pulley, for removing tramp iron from conveyed coal, has new ribbed construction, including deeper coil pockets that allow for more copper wire and more ampere turns with consequent greater magnetic strength Non-magnetic end rings of alloy steel extend beyond active face of pole and



supoprt unloaded edges of belt, confining magnetic force of pulley to active portion of belt. One-piece magnet body is fixed on steel shaft by heavy steel hubs, welded to supporting arms and keyed in position abutting shoulder of the oversize portion of shaft.

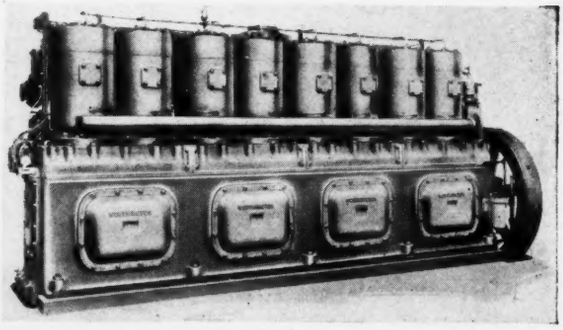
Stearns Magnetic Mfg Co, Milwaukee.



2500-lb Safety Valve

SPECIAL alloy steels with low coefficients of expansion are used for bodies, bonnets, springs and trim. Bodies and bonnets are assembled with through bolts to prevent "freezing" at high temperatures. Trim is treated stainless steel. Constant seat diameter is insured by new bevel seat in which actual contact bearing between seat and disk is always at lowest portion of seat surface. Single-ring blowdown control. Designed for high temperature and pressure (2500 lb at 1000 F).

Consolidated Safety Valve Div, Manning, Maxwell & Moore, Inc, Bridgeport, Conn.



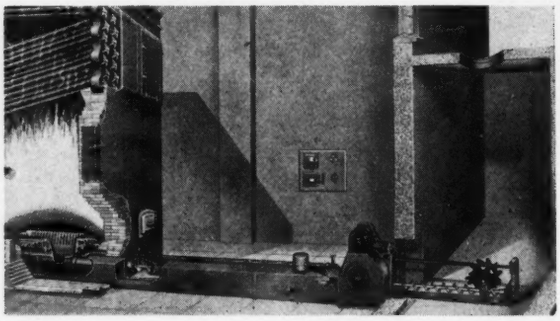
Gas Engine *(upper right)*

TYPE LPE, vertical, 4-cycle engine is of multi-cyl, trunk-piston type with L-head cylinders arranged in line. Totally enclosed with pressure lubrication throughout. Straight-line arrangement of cylinders gives accessibility and permits equal intervals between power impulses. This latter feature produces uniform turning effort and smooth operation with small flywheel. A single magneto can be used for all cylinders. Made in 4-, 6- and 8-cyl units, rated 180, 270 and 360 hp, at 400 rpm.

Worthington Pump & Machinery Corp, Harrison, N. J.

Stoker *(above)*

"COAL FLOW" stoker, for boilers up to 3000 sq ft, has integral coal conveying mechanism, so that coal is brought automatically from main bunker to fire. All operating mechanism is in the boiler room, outside the coal bunker. Electrically controlled automatic firing maintains desired steam pressure regardless of peak loads. Other features include: metering feed worm, volumeter air regulator that gives automatic control of



air volume in combustion zone, and centro-balanced rotor fan. V-belts on both transmission and fan drives.

Iron Fireman Mfg Co, 3170 W 106th St, Cleveland, Ohio.

Variable-Speed Transmission

"SELECT-O-SPEED" transmission gives infinite selection of speeds over a 5 to 1 ratio by movement of control lever. Variation of speed ratio is made possible

by arrangement of two interlocking sheaves, which may be pivoted laterally by control lever to change driving- and driven-belt tensions. This change automatically causes sheaves to adjust themselves to a new pitch diameter for new speed ratio. Sizes to 7½ hp.

Ideal Commutator Dresser Co, 1232 Park Ave, Sycamore, Ill.

Lube-Oil Purifier

SELF-CONTAINED centrifugal oil purifier enables colloidal carbon to be removed continuously without aid of chemicals. This process is based on the discovery that water properly atomized in oil containing colloidal carbon acts as a coagulant, neutralizing the electric charge carried by carbon particles and stopping "Brownian movement" that interferes

AFTER 72,000 HOURS... CYLINDER WALLS STILL SHOW ORIGINAL TOOL MARKS!

• SINCE JUNE 1927 a 480 H.P. Uniflow engine has operated 24 hours a day, six days a week, on StanoCyl Steam Cylinder Oil. On a recent inspection, after 72,000 hours of operation, the cylinder walls still showed the original tool marks and the rings were in perfect condition.

Reports such as this on the excellent lubricating quality of StanoCyl are made more remarkable when you realize that switching to StanoCyl will almost invariably reduce oil consumption. Savings up to 50% have been made in many plants.

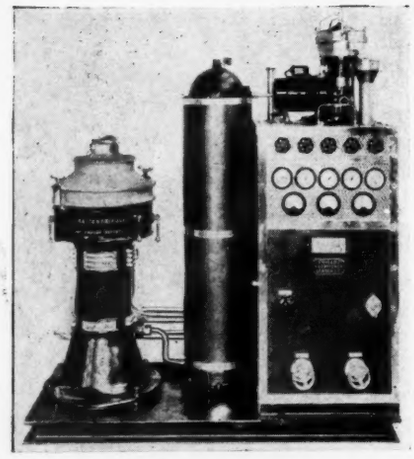
There are three grades of StanoCyl to meet every condition of operation. A Standard Lubrication Engineer will gladly recommend the grade you need and help you get the full economy that StanoCyl has brought to others. Call your local Standard Oil (Ind.) office, or write 910 South Michigan Avenue, Chicago, Illinois, and ask to have a Standard Lubrication Engineer see you—his service is free.

Copr. 1938, Standard Oil Co.

STANOCYL
STEAM CYLINDER OIL

STANDARD OIL COMPANY (INDIANA)

LUBRICATION ENGINEERING — THE RIGHT LUBRICANT • PROPERLY APPLIED TO REDUCE COSTS

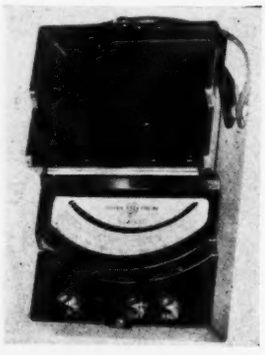


with precipitation. The equipment, called a Colloid Coagulator, consists of a small disk rotor, running at 10,000 rpm; provided with vortex passages, which create turbulence between the liquids and ensure desired degree of atomisation. Oil-water mixture is collected in a detachable casing and from it is discharged into a time-lag tank surrounding the rotor, which is driven through a single train of worm gearing by a flange mounted, 2800-rpm, 1-hp motor. Cleaning capacity is about 100 gal. of dirty oil per hr.

A W Empson, 4/5 Bond Court, Walbrook, London, E.C.4, England.

Portable Pyrometer

SHOCK-PROOF portable pyrometer has these essential features: Spring-suspended movement within case to mini-

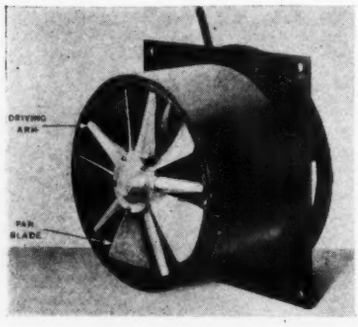


mize shock and jars; shock-resisting movement with pivots and jewels; new type pointer lock to damp movement of instrument when carried; heavy metal case; shatter-proof glass; and scale length of 5 in.

Illinois Testing Laboratories, Inc, Chicago, Ill.

Gas Burner

"FANMIX" rotary gas burner consists of a long-hub fan in which two ball bearings are mounted so that fan rotates on a stationary shaft that serves as gas-inlet pipe. Gas is admitted through hollow shaft and enters fan hub. The fan has driving arms as well as air blades. Gas flows into these arms, leaves them through small orifices and, by reaction, causes the fan to rotate at high speed. The fan blades then act as any other power-driven fan, delivering air for combustion. Number of orifices in driving

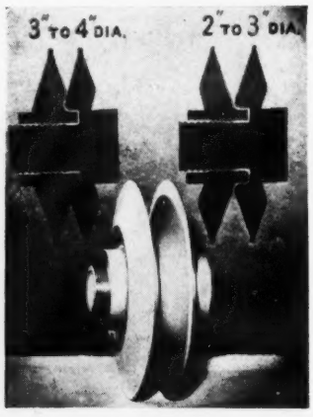


arms as well as gas pressure determines amount of gas flow, and reaction force determines fan speed and hence air delivery. Operates at gas pressures of 5 to 40 lb.

Coppus Engrg Corp, Worcester, Mass.

Adjustable Sheave

SINGLE-GROOVE, adjustable sheave has a range of pitch diameters by moving adjustable plate, reversing and again placing on hub. Outer plate in position shown at left allows Texrope belts to rise high and give pitch diameter from

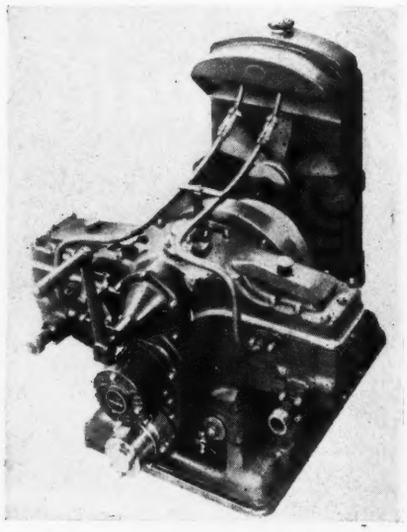


3 to 4 in.; outer plate reversed in position shown at right allows belts to ride low and give pitch diameter from 2 to 3 in.; the two together provide for a speed variation of 100%.

Allis-Chalmers Mfg Co, Milwaukee, Wis.

Diesel Engine

COVIC, opposed cylinder, 4-cycle, valve-in-head, 3 5/32-in. bore, 3 5/16-in. stroke diesel is rated 15-18 hp. Weight with hand-cranking system and 60-lb flywheel is 280 lb. Water and lube-oil pumps are mounted on same shaft, driven from



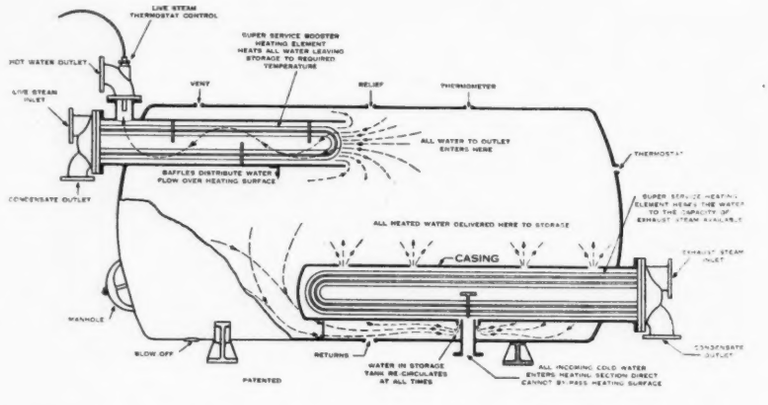
crankshaft. Fuel pumps and fuel injectors are Bosch. Made in a complete range of models for direct power take-off, drives for main line shafts, etc.

Northill Co, Inc, Los Angeles, Calif.

Storage Heater

"SUPER-SERVICE" storage heater provides for complete contact of water and heating surface. Entering water passes directly into bottom of a casing enclosing heater element. Outflow openings at casing top are so proportioned that flow of water before passing to storage is distributed over entire heating surface. Water-inlet at bottom of casing is also proportioned to cause recirculation of storage water at all times, whether it is being drawn or not. Illustration shows storage heater with booster heating element (upper left), consisting of removable copper U-bends enclosed in a casing, open at the end within the tank. This provides additional means of maintaining final temperature when exhaust or low-pressure steam is not available in sufficient quantities to heat required amount of water.

National Pipe Bending Co, 117 River St, New Haven, Conn.



In Good Standing

ON ALL POWER PLANT SERVICE

High Pressure Steam Valve with Welding Ends.

CHAPMAN STEEL VALVES ARE MADE IN THESE ALLOYS

Carbon Steel.
Carbon Molybdenum Steel.
Chrome Nickel Steel.
Nickel Steel.
Chrome Molybdenum Steel.
Chrome Tungsten Steel.
Chrome Nickel Tungsten Steel.

To be a member in good standing for modern power plant service, valves must meet exacting obligations. And this Chapman does:

Chapman Valves—from the smallest to the largest—are built to rigid standards. Castings must be flawless. Parts precision machined. Valves thoroughly tested.

Chapman Power Plant Valves are made in seven special steels—steels that are chosen for their ability to stand up under temperatures to 1000°F., pressures to 1500 lbs., as well as corrosive and other troublesome operating conditions. These steels are made and poured in Chapman's own foundry—under metallurgical supervision where each melt is controlled, each steel tested.

Keep all your valves in good standing. Specify Chapman—gate, globe, check and angle valves: with all types of operating mechanisms. Write.

The Chapman Valve Mfg. Co. *Indian Orchard, Mass.*

CHAPMAN POWER PLANT VALVES

What's a Hookup?. . .

"BUT, DAD, what's a hookup?", asked the boy. That pulled me up sharp in my tracks. "Why, a hookup is . . ." —and I was floundering over my depth, and his. I thought of "heat diagram" and "flow diagram", and "chart of the flow of steam and water", but not one of them sounded right.

I'd been going on at a great rate, telling the Kid about some 3-dimensional hookup models I'd seen that afternoon—but maybe I'd better start at the beginning. Well, I'd stopped in to see Phil Swain, editor of *Power*, and he'd been telling me about a brand new picture plan for December *Power*. It seems that he and "the boys" have been hard at work for a year or more, making little boilers, turbines, and what not in some celluloid-like material, then connecting them up with pieces of wire and taking pictures of them.

It sounded pretty much like bats in the belfry to me—until he showed me a hookup diagram and one of their pictures. Even then I felt like the back-country boy who saw a giraffe for the first time and said, "There just ain't no such animile!"

To begin with, a power plant is a pretty complicated piece of machinery. It's so cut up with brick and mortar and steel gratings and complicated piping that it's impossible to get any clear idea of the plant itself. A hookup diagram cuts out all that, and with a little study, gives you an understanding of what your plant really is. But these pictures go about three steps beyond any diagram—for they show hookups in three dimensions so clearly that you get the whole idea at a glance. And then other pictures show what happens when you add a condenser, or change the feed-water circuit, or add a pump—how you can make a better, more-economical plant out of what you have.

It all grew out of the popularity of the Hookup Number *Power* published about eight years ago. I still have my copy—but the new one in December will beat that all hollow.

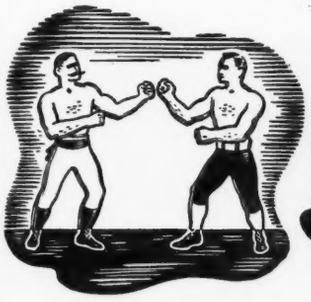
But I'm getting off my story. I'd been telling the boy about these hundred models and 60 or 70 hookups and how they were made. And then his "What's a hookup?"

Well, what is a hookup? Try to explain it in simple words. Sure, it's a heat-flow diagram, or anything else you want to call it, but it's a whale of a lot more than that. It's efficiency and economy, or it's waste. It's the plant you've got, and maybe the plant you're going to have. It's what you've got to work with, and what you're going to need. It may be a graphic testimonial to your ability, or a damning admission that you aren't worth your salt. But most of all, it's a chance to do something better, something more suited to the particular job—or proof that you've got the answer now. If you've never seen a hookup of your plant, look it up, and compare it in December with what it ought to be. And meanwhile, figure out for me a simple answer to this simple question, "What's a hookup?"

George Edwards

Engineer

SULLIVAN & NICKEL



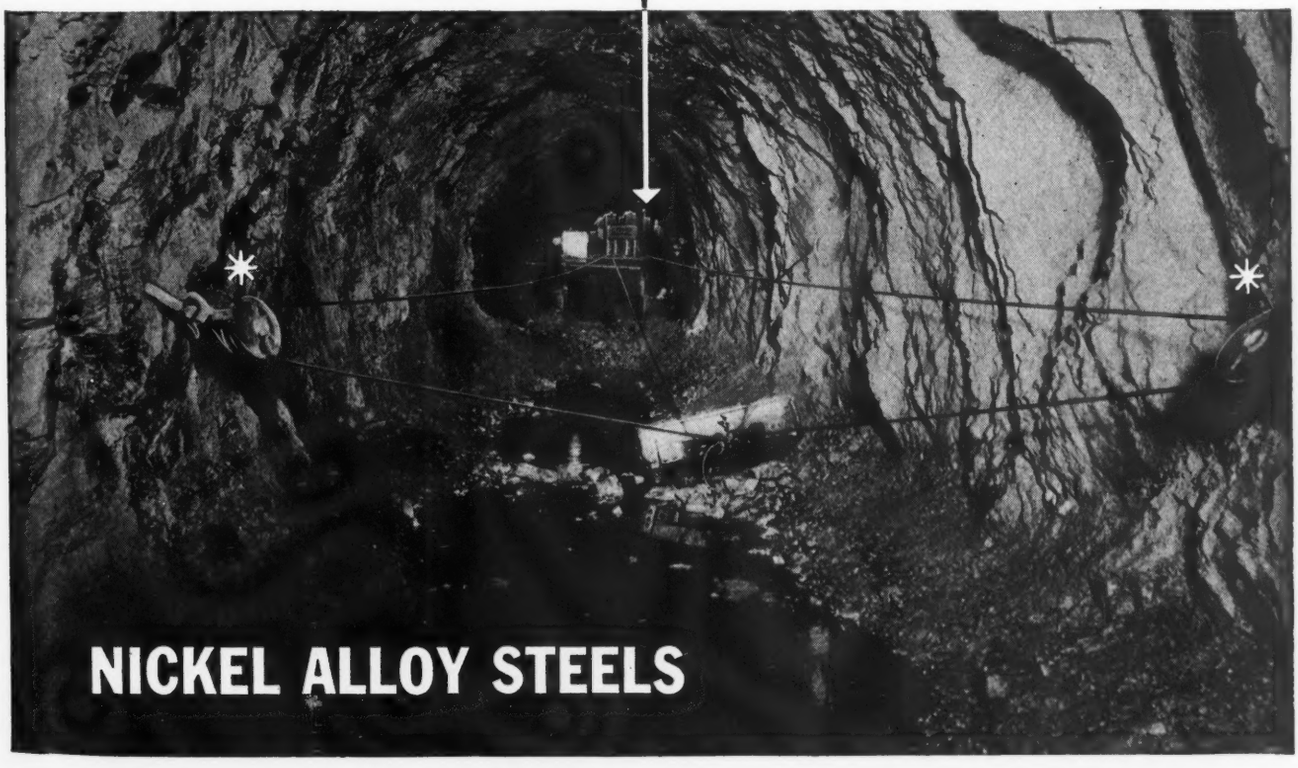
..This pair gives PRODUCTION COSTS a beating!

From South Africa to Northern Canada, more than 11,000 tough jobs of scraping and hoisting prove that Sullivan and Nickel are a pair that is hard to beat.

SULLIVAN—the Sullivan Machinery Co., Claremont, N. H.—contributes two-lever control, faster tail rope speeds and tough sheaves and other Sullivan improvements which move more tonnage out of the ground.

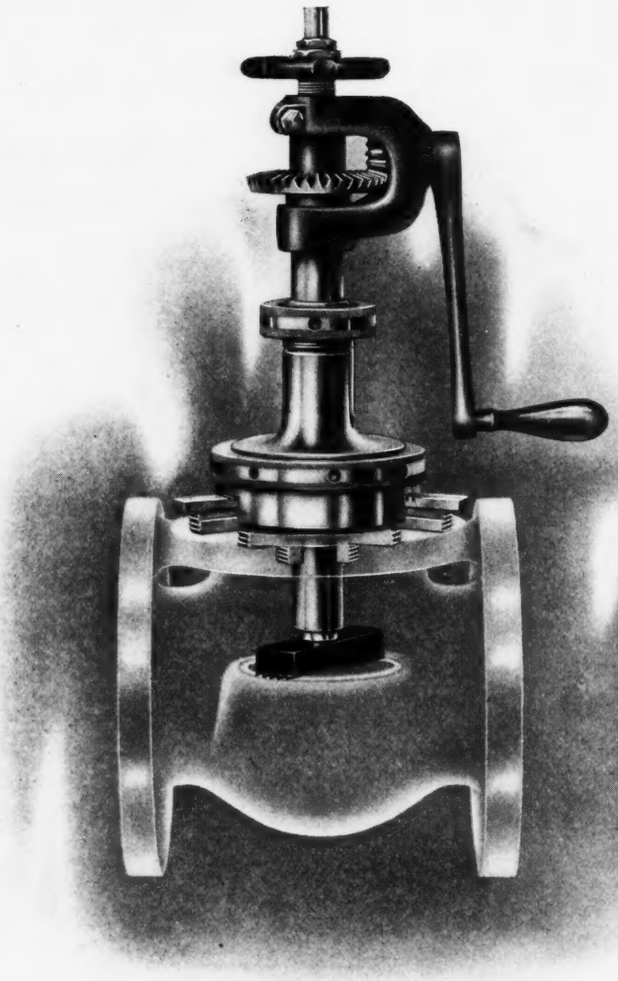
NICKEL—the fundamental alloying element—contributes extra strength to Sullivan's splash proof motors and practically wear proof gears. Gears are forged from SAE 3145 Nickel-chromium steel, heat treated, and from SAE 4615 Nickel molybdenum steel, case hardened. For shafts, Sullivan depends on Nickel-chromium steel, SAE 3145, heat treated.

✶ For these hard-working roller sheaves, Sullivan developed a cast Nickel-chromium steel, similar to SAE 3140. These Nickel alloy steel castings are heat treated to a Brinell hardness of 375 and a tensile strength of 180,000 p.s.i. Sullivan sheaves have proved so successful they are now used by mining and construction companies all over the world. Reputations are built upon uniformly dependable, premium-quality materials such as fine Nickel alloy steels.



THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

KEEP YOUR GLOBE VALVES TIGHT SEATING



The Dexter Globe Valve Reseating Machine is quickly and easily secured to the valve and the seat refaced smooth and true. It can be done with the valve in place. The disc is refaced in the disc cutter which is part of the outfit.

The machine can be supplied in various capacities and the cost is small in comparison with the savings made. It's an indispensable tool.

Write for Catalog No. 24 describing this machine and the Dexter Machines for gate valves and pump valve seats.

Also manufacturers of the Swendeman Automatic Separators which eliminate water and oil from compressed air.

THE LEAVITT MACHINE CO.

10 EAST RIVER ST. ORANGE, MASS.

Canadian Distributors:—

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15 Branches Throughout Canada

Readers' Problems

(*Continued from page* 116)

is not subject to changing loads, and where the shaft is held by steel stringers, the same thing is true.

However, where the shaft is not properly supported with respect to its loads and the shaft supports give considerably under increased loading, I have found that shaft power losses are kept at a minimum when the shaft is aligned when running under average load conditions. The losses are increased when the shaft is idling, but I assume that the shaft runs under load more than without load.

Worcester, Mass. STUART GOURLEY

STRAWS

(*Continued from page* 104)

FLORIDA——Arcadia is having plans prepared by James E. Craig, Miami, Fla., consulting engineer, for municipal electric plant, and will place orders for equipment soon. Cost over $100,000. Financing through Federal aid.

Tallahasse plans cold-storage plant in connection with new municipal abattoir. Cost about $61,000. Financing through Federal aid. E D Fitchner, Tallahasse, architect.

Clearwater plans municipal electric plant, for which a fund of $397,000 is being secured through Federal aid. An electrical distributing system will be installed to cost about $230,000, with financing through same source.

City Commission, Niceville, plans municipal ice-manufacturing and cold-storage plant, with ice-making capacity of about 30 tons per day and cold-storage division with capacity of about 400,000 lb of fish and other food products. Estimates of cost are being made and financing will be arranged soon. R G Patterson, Pensacola, consulting engineer.

GEORGIA——Alpharetta plans deepwell pumping machinery and accessories, and 50,000-gal. elevated steel tank and tower for municipal waterworks. Fund of $28,600 has been arranged through Federal aid for this and other equipment for system.

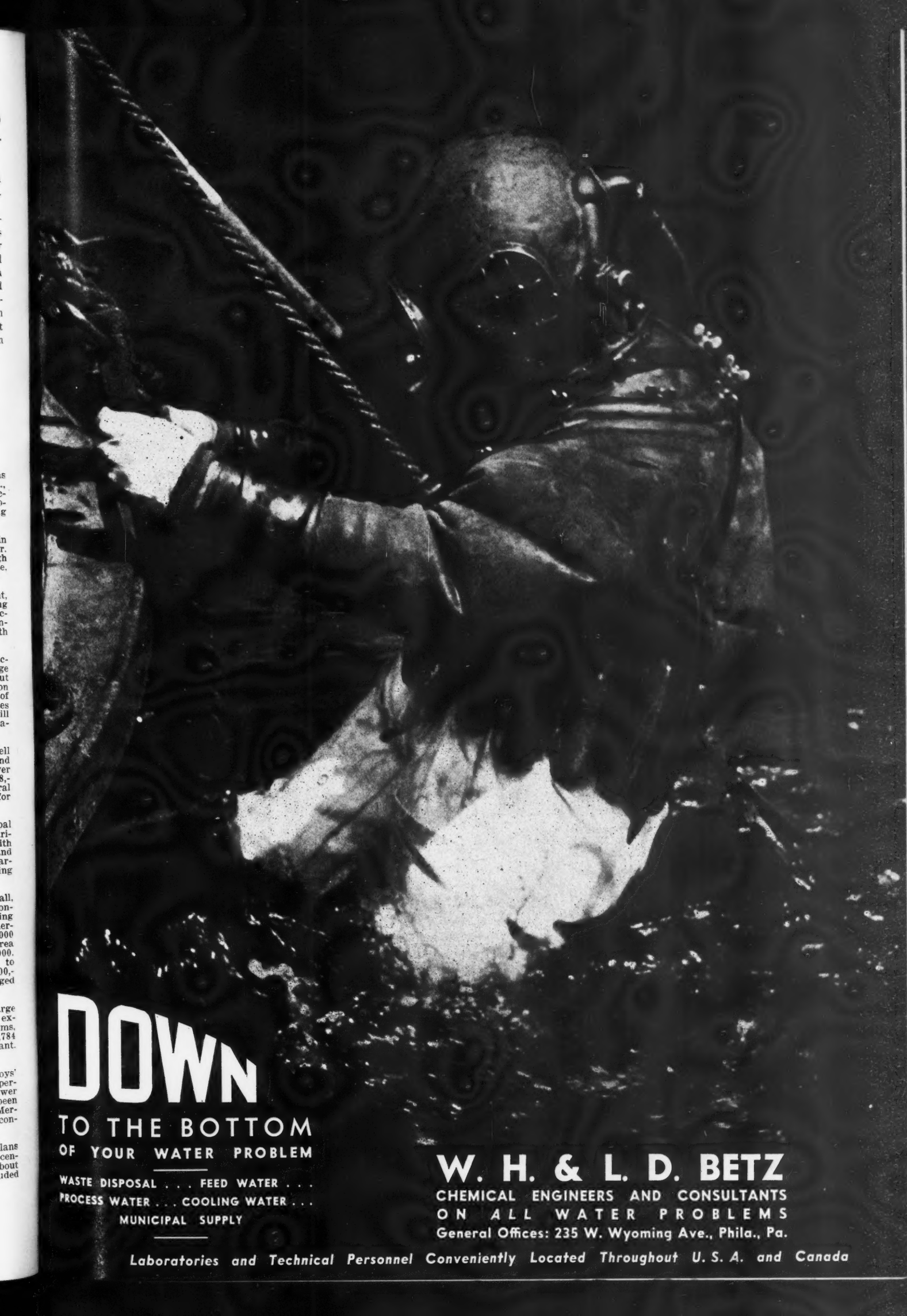
IDAHO——St. Anthony plans municipal hydroelectric plant and electrical distributing lines. Cost about $327,000 with hydraulic turbines, generators and auxiliary equipment. Financing being arranged through Federal aid, including $147,141 Federal grant.

ILLINOIS——Water Bureau, City Hall, Chicago, plans water meters for all consumers on South Side of city using filtered water from new municipal water-filtration plant and system. About 49,000 meter installations will be made in area south of Pershing Rd., to cost $1,860,000. Complete meter system is estimated to cost about $9,000,000. A fund of $21,000,000 for filtration plant is being arranged through Federal aid.

INDIANA——Hammond plans large pumping station in connection with extensions in water and sewerage systems, to cost $3,195,075, of which $1,437,784 has been secured through Federal grant. Work is scheduled to begin soon.

Board of Trustees, Industrial Boys' School, Plainfield, E Millard Dill, superintendent, plans improvements in power house at institution. Financing has been arranged. John M Rotz Engrg Co, Merchants' Bank Bldg, Indianapolis, consulting engineer.

Board of School Trustees, Kokomo, plans central heating plant for junior high, central high and grade school. Cost about $335,000. Financing has been concluded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100 Mermaid Ave. Philadelphia

through federal aid. McGuire & Shook, Fletcher Trust Bldg, Indianapolis, architects.

IOWA——Manly plans municipal electric plant, using diesel-generator units and accessories. Cost about $125,000. Financing is being arranged.

Board of Cerro Gordo County Commissioners, Mason City, plan central heating plant in new court house. Cost about $475,000. Financing through Federal aid. Hanson & Waggoner, Mason City, architects.

Board of Trustees, University of Iowa, Iowa City, Iowa, W H Cobb, business manager, plans air-conditioning system in three buildings at institution. Cost about $35,000. Financing through Federal aid. George Horner, Iowa City, architect.

State Board of Control, State House, Des Moines, plans steam power house at institution at Fort Madison, with installation of boilers and auxiliary equipment. Cost about $218,000. Financing through Federal aid.

Dayton plans municipal electric plant. Proposed to use diesel-generator units and accessories. Cost about $50,000, of which $25,200 will be represented by a Federal grant. Ralph W Gearhart, 349 21st St, S.E., Cedar Rapids, Iowa, consulting engineer.

Spencer plans expansion in municipal electric plant and waterworks station. Cost about $163,000, of which approximately one-half will be used for each project. Burns & McDonnell Engrg Co, 107 W Linwood Blvd, Kansas City, Mo., consulting engineer.

Stuart will award contracts soon for extensions in municipal power plant, including two new diesel-generator units and auxiliary equipment. H S Nixon, Grain Exchange Bldg., Omaha, Neb., consulting engineer.

Glidden plans improvements in municipal electric plant. Cost about $43,000, of which $19,400 will be secured through Federal grant. Young & Stanley, Inc, Muscatine, consulting engineer.

KANSAS——Kingman plans extensions in municipal power plant, including new 750-hp diesel unit and auxiliary equipment. Cost about $53,000. Financing is being arranged through Federal aid. Frank Spurrier, Kingman, consulting engineer.

Hillsboro plans municipal gas-distributing system, with control station and other operating facilities. Cost about $49,000, of which $22,050 has been secured through Federal grant. Work scheduled to begin soon. Hefling & Hunter, East 2nd St, Hutchinson, consulting engineers.

KENTUCKY——Owensboro is completing plans for expansion in municipal power plant, to include new 7500-kw turbine-generator, two boilers, stokers, coal bunkers and other miscellaneous equipment. Also will make extensions in waterworks station and system, with installation of new water-softening and filtration plant, additional pumping machinery and accessories, tank, etc. Fund of $2,313,000 has been arranged for entire project, of which $1,041,016 is a Federal grant. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

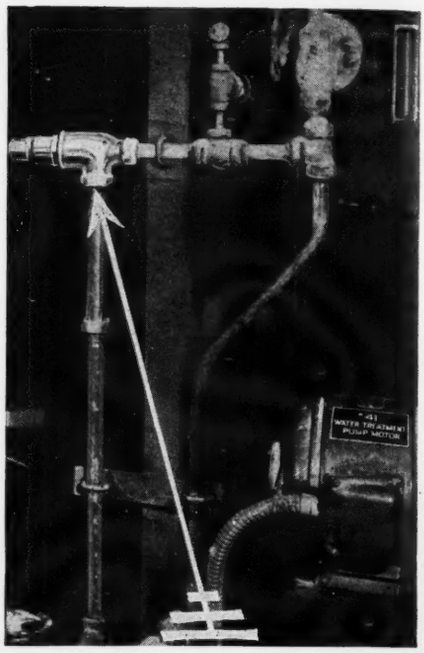
LOUISIANA——Peoples Gas & Fuel Co, Inc, Minden, plans extensions in pipeline system and operating facilities for natural gas distribution in parts of Webster Parish. Cost close to $40,000.

Ruston has plans nearing completion for municipal electric plant, using diesel-generator units and accessories. Cost about $125,000. Financing being arranged through Federal aid. J W Smith & Associates, Monroe, architects and engineers.

Lake Charles plans central-heating plant for two new municipal buildings, comprising administration and stock exhibit structures, respectively. Cost about $900,000. Financing through Federal aid.

MARYLAND——Chemical Pigment Co, St. Helena Ave, Baltimore, plans boiler house at local chemical plant. Cost over $50,000, with boiler units, pumps and auxiliary equipment.

MASSACHUSETTS——Board of School



CONSOLIDATED EDISON
Installs
LONERGAN HDF's

Illustration shows one of a series of Lonergan HDF's installed by Consolidated Edison Company in their Waterside Plant, New York City. Welded and operated under 1500 pounds pressure as pump relief valves on the boiler feed water treatment pumps.

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High Pressure Relief Valve

Heavy drop-forged steel body with cast steel bonnet and cap. Seats—either monel or stainless steel as specified. Suitable for high pressure hydraulic, oil or gas service. ¼" to 2". Can be furnished with exposed spring.

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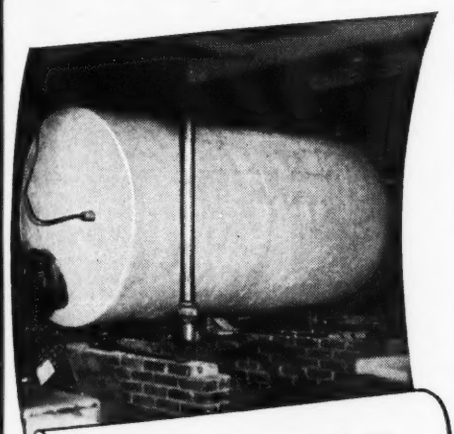
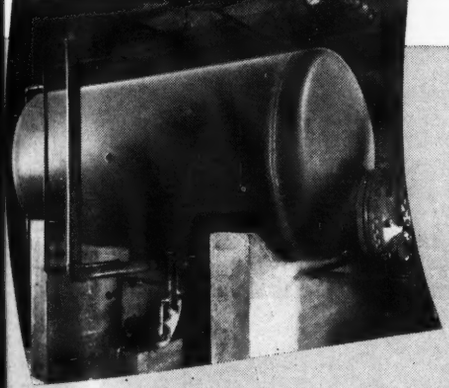
For *non-rust water heaters of all types* EVERDUR METAL *gets the call*

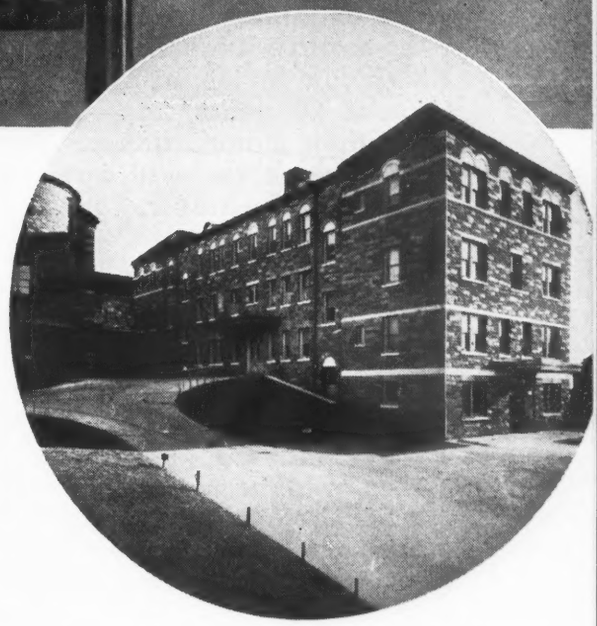


Two WHITLOCK EVERDUR Heaters recently installed in, *above*, the laundry of the College of William & Mary, Williamsburg, Va., and, *below*, the new United States Mint at San Francisco.



Nowadays more EVERDUR heaters are installed in a week than were built in the entire year 1929. For owners have learned that rustable, short-lived heaters are a false economy. They are demanding clean hot water, long heater life and consequent freedom from rust-repairs and replacements.

EVERDUR Copper-Silicon Alloy best meets these requirements. It is exceptionally strong, rustless as copper, and readily welded. This rare combination of properties means rust-free hot water indefinitely, and lasting service at low cost. For all types of industrial, commercial and residential installations, EVERDUR storage heaters are obtainable from leading equipment manufacturers. 3897



WHITLOCK EVERDUR Heater, *shown above*, installed in St. Francis Hospital, Wilmington, Delaware. *Architect:* Peter F. Getz, Philadelphia. Made by The Whitlock Coil Pipe Co., Hartford, Conn., this heater measures 48" x 120", and has a heating capacity of 1000 g. p. h. from 40° to 180°F. with steam at 2#.

• • •

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"Jagabi" Rheostats
"Jagabi" Speed-Measuring Instruments

Trustees, Canton, plans central-heating plant in new 2- and 3-story junior and senior high school. Cost close to $275,000. Financing being arranged through Federal aid. Markus & Nocka, 184 Boylston St, Boston, architects.

Board of School Trustees, Northampton, plans central-heating plant in new 3-story and basement high school. Cost about $800,000, of which $337,000 will be a Federal grant. J William Beal Sons, 187 Devonshire St, Boston, architects.

Pocahontas Fuel Co, Statler Bldg, Boston, has approved plans for steam power house at plant at Portland, Me. Cost over $45,000, with equipment. Fay, Spofford & Thorndike, Statler Bldg, Boston, consulting engineers.

MICHIGAN——Tri-County Electric Co-operative, Eaton Rapids, contracted Worthington Pump & Machinery Corp, at $62,856 for generating equipment and accessories for electric power plant.

Michigan Sugar Co, Saginaw, plans extensions in steam power house at local beet-sugar mill, including additional equipment. Cost over $60,000. Similar work will be carried out at power house at branch mill at Caro.

Menominee has plans maturing for municipal electric plant. Cost about $890,000 with turbine-generator and auxiliary equipment. Financing being arranged through Federal aid. Francis Engrg Co, Saginaw, consulting engineer.

Holland plans municipal electric plant, to include 15,000-kw steam turbine-generator and auxiliary equipment. Cost about $1,500,000, of which $675,000 will represent a Federal grant. Work is scheduled to begin soon. Hamilton & Weeber, Grand Rapids, consulting engineers.

Saginaw has engaged Burns & McDonnell Engrg Co, 107 W Linwood Blvd, Kansas City, Mo., consulting engineers, to make surveys and estimates of cost for proposed municipal electric plant. Financing will be arranged through Federal aid.

School Board, Marinesco, plans central-heating plant for school buildings. Cost about $25,000. Financing through Federal aid. Charles Foster, Medical Arts Bldg, Duluth, Minn., consulting engineer.

MINNESOTA——Janesville will award contracts soon for diesel-generating unit and accessories, switchboard and complete auxiliary equipment for municipal power plant. Cost estimated at $100,000. G M Orr & Co, Baker Bldg, Minneapolis, consulting engineers.

Litchfield plans improvements in waterworks pumping station, including new 5000-sq ft boiler unit and auxiliary equipment, pumping machinery and accessories. Financing through Federal aid. Charles H Foster, Medical Arts Bldg, Duluth, consulting engineer.

Winthrop plans municipal steam power plant for central-heating service and pipeline distributing system, to include two boiler units and accessories, stokers, vacuum pumps and auxiliary equipment. Cost about $108,000, of which $48,773 will be a Federal grant. Rose & Harris, Essex Bldg, Minneapolis, consulting engineers.

Buffalo plans municipal power plant for lighting and heating service. Cost about $90,000, of which $40,500 will be a Federal grant. G M Orr & Co, Baker Arcade Bldg, Minneapolis, consulting engineers.

MISSISSIPPI——Morton plans municipal cold-storage plant in connection with new meat-curing plant. Cost over $50,000, with equipment. Financing has been arranged. Work is scheduled to begin soon.

Prentiss plans early rebuilding of portion of municipal electric plant and waterworks station, recently destroyed by fire. New equipment will be installed. Cost about $30,000. Bond issue is being arranged.

Krouse & Brasfield, Meridian, architects, have plans under way for cold-storage and refrigerating plant on local site. Bids will be asked soon. Cost about $140,000, with equipment.

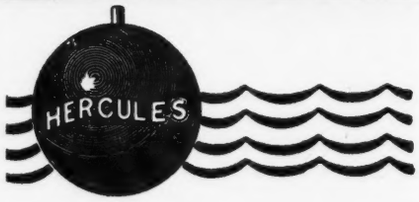
Board of Holmes County Supervisors,

(*Continued on page* 134)

HERCULES

Seamless Copper

FLOATS



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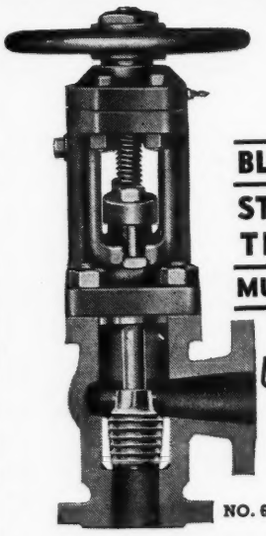

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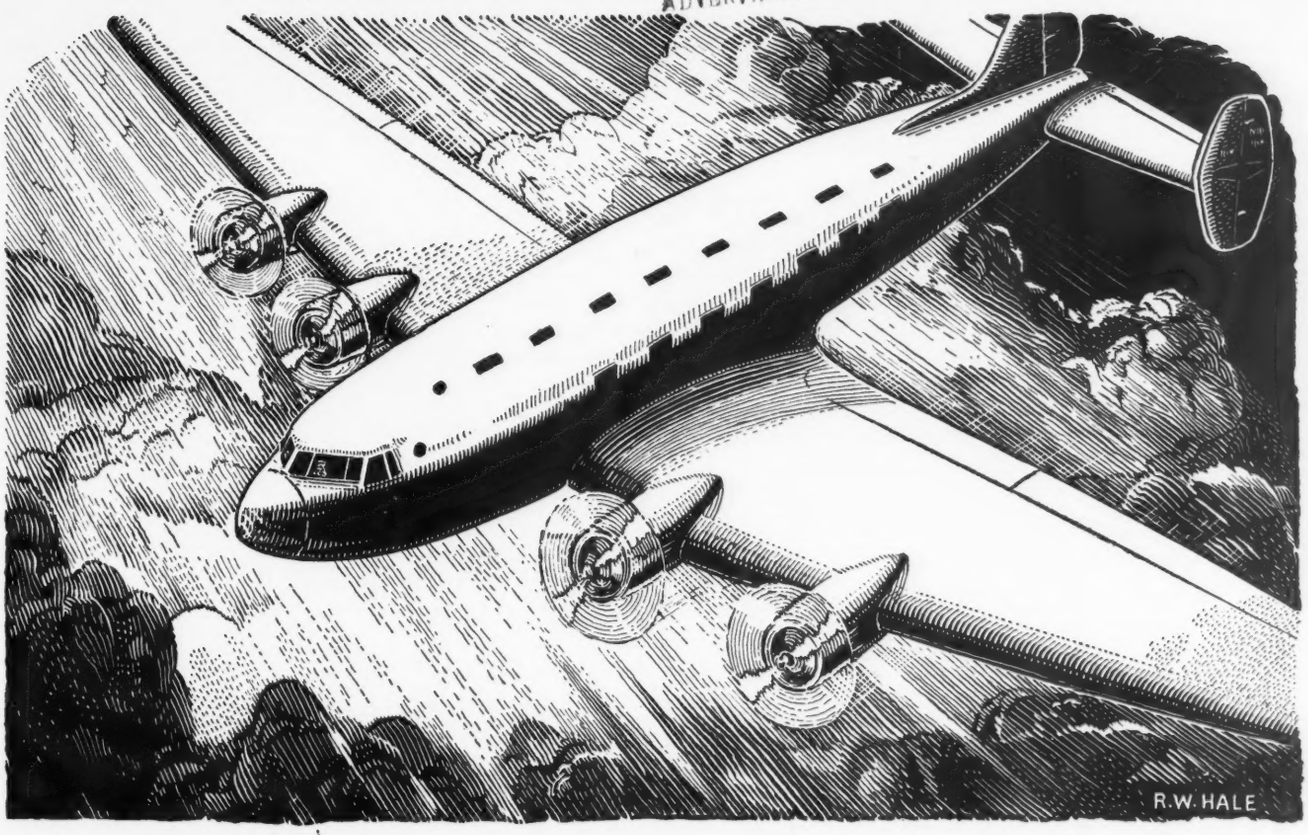

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Write for Bulletin 42-A

SIMPLEX VALVE AND METER COMPANY
6780 Upland Street **Philadelphia, Pa.**

Lexington, is considering local county-owned cold storage and refrigerating plant. Cost over $50,000, with equipment. T M Williams, Durant, Holmes County agent, is active in project.

MISSOURI——Liberty plans municipal electric plant and electrical distributing system. Cost about $300,000. Financing through Federal aid. W B Rollins & Co, Railway Exchange Bldg, Kansas City, consulting engineers.

Carrollton plans municipal electric plant. Proposed to use diesel-generator units and accessories. Cost about $235,000. Financing through Federal aid. Burns & McDonnell Engrg Co, 107 W Linwood Blvd, Kansas City, consulting engineer.

Vandalia plans municipal electric plant, using diesel-generating units. Also will install municipal electric distributing system. Cost about $170,000, of which $77,000 has been secured through Federal grant.

Pleasantville plans municipal electric plant and distributing system. Cost about $165,000. Proposed to use diesel-generator units and auxiliaries. Financing through Federal aid. W B Rollins & Co, Railway Exchange Bldg, Kansas City, consulting engineers.

Eldorado Springs plans municipal electric plant and electrical distribution system. Proposed to use diesel-generator units. Cost about $120,000. Financing through Federal aid. W B Rollins & Co, Railway Exchange Bldg, Kansas City, consulting engineers.

MONTANA——Board of Education, Billings, plans central-heating plant in new 3-story senior high school on Grand Ave. Cost about $900,000. Financing has been arranged through Federal aid. William E Ittner, Inc, 911 Locust St, St. Louis, Mo., architect.

NEBRASKA——David City plans extensions in municipal electric plant. Bids will be asked soon. Cost about $65,000. C Robert Fulton, 2527 South 19th St, Lincoln, consulting engineer.

Hyannis has authorized surveys and estimates of cost for extensions in municipal electric plant, including additional equipment. Financing through Federal aid. Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

NEW JERSEY——Department of Hospitals, Medical Center, Baldwin Ave, Jersey City, plans central-heating plant in new 14-story hospital for children. Cost about $2,000,000. Financing being arranged through Federal grant and bond issue.

City Council, Elizabeth, plans central-heating plant in new city hall building. Cost about $750,000. Financing through Federal aid. Albert S Kaufmann, architect. P F McGann, councilman, chairman of committee in charge.

NORTH CAROLINA——New Bern plans improvements in municipal power plant and waterworks station, including considerable new equipment. Cost about $370,000, of which $168,000 will be a Federal grant. Proposed to ask bids soon.

Greenville plans improvements in municipal electric plant, including new 5000-kw generating unit, boiler and auxiliary equipment. Cost about $375,000. Financing has been concluded through Federal aid and work will begin soon.

Washington plans extensions in municipal electric plant, including new boiler unit and accessories, coal- and ash-handling equipment, pumping machinery and other equipment, and construction of new stack. Cost about $187,000, of which $84,000 will be secured through Federal grant.

Halifax plans early purchase of deep-well pumping machinery and auxiliary equipment, and 75,000-gal. elevated steel tank and tower, in connection with extensions in municipal water system. Fund of $60,000 has been secured through Federal aid for entire project.

NORTH DAKOTA——State Board of Administration, Bismarck, A B Welch, executive secretary, plans early call for bids for extensions in power house at institution at Minot, including installation of two new boilers to replace present

ZEO-KARB H IS NEWS

New Feedwater process BY ION EXCHANGE ALONE removes scale— Prevents sludge—Inhibits corrosion— Lowers alkalinity—Reduces total dissolved solids!

Today's higher pressures and improvements in boiler design demand a more efficient feedwater treatment. As a result, The Permutit Company has exclusively developed a revolutionary feedwater conditioner, *Zeo-Karb H*. This improves upon both the Zeolite and Hot Lime Soda processes!

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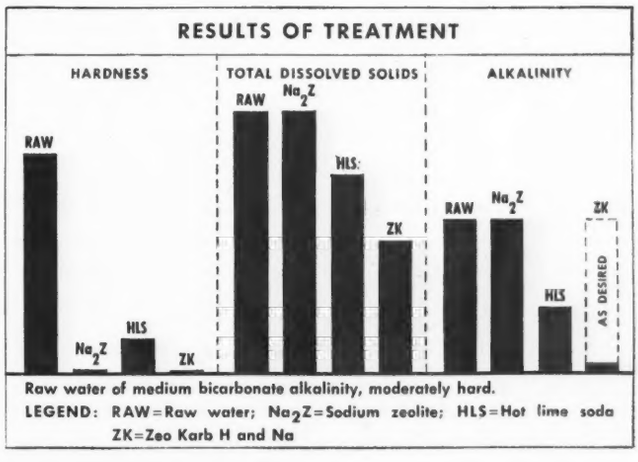
Now, while actual plant operations prove that Zeo-Karb H treats feedwater *far* more efficiently than any other known process, it may not be the one and only answer to *your* problem. The composition of your water, or some other factor, may make another process more suitable for your particular plant.

How can you tell? There's one sure way: See the Permutit engineer! Without obligation, he will make a thorough analysis of your water, your needs. He will then make recommendations—backed by years of experience in solving all sorts of feedwater problems. And you can depend on his *unbiased* advice. For he represents Permutit—world's largest specialist in *every* type of feedwater equipment. Permutit does not have to sell any one process. Instead, Permutit's interest is to *save you the most money*. Yes, it will pay you to send for the Permutit engineer—today!

Would you like a free, authoritative booklet on Zeo-Karb H? Or on some other feedwater process? Just send to The Permutit Company, Dept. A, 330 West 42nd Street, New York.



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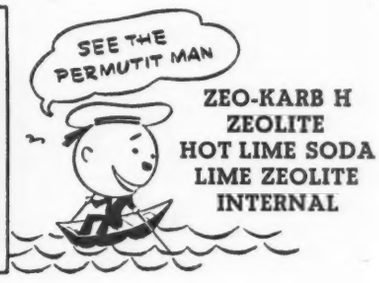
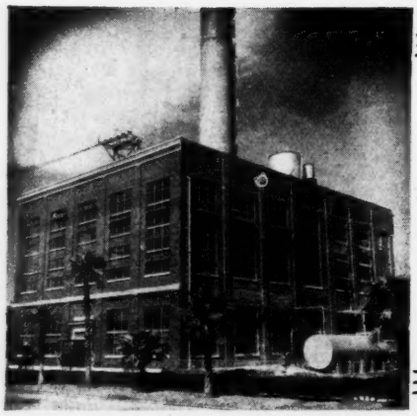
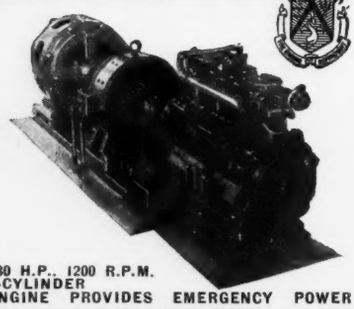
The Water Conditioning Headquarters
over 25 years







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Florida Power Corporation's Bayboro Plant, located at south end of system, dispenses with standby steam boiler — eliminates maintenance of 50 lb steam pressure — keeps boilers warm with out-side steam. The Sterling Engine supplies motive power for the house service generator, for bringing one boiler and the plant on the line.

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Write for Bulletin A-3.

THE WATSON-STILLMAN CO.
ROSELLE, N. J.

units, preheaters, pumping machinery, etc. Cost about $63,600. Also will make similar improvements in power house at institution at Valley City, with additional equipment. Cost about $30,000. Financing has been concluded through Federal aid. William F Kurke, 1117 13th Ave, Fargo, consulting engineer.

Valley City plans extensions in municipal power plant. Cost about $161,700. Financing has been arranged, including Federal grant of $72,787. Burlingame, Hitchcock & Estabrook, Inc, Sexton Bldg, Minneapolis, Minn., consulting engineer.

OHIO——Shelby plans improvements in municipal electric plant. Work will begin soon. Fund of $200,000 has been secured through Federal aid.

Monroeville has authorized surveys and estimates of cost for municipal electric plant. Financing will be arranged through Federal aid. William C Kammerer & Associates, Euclid Bldg, Cleveland, consulting engineers.

Bluffton plans expansion in municipal electric plant. Cost about $42,600. Financing through Federal aid. Carl J Simon & Associates, Evans-Central Bldg, Van Wert, consulting engineers.

Pioneer Food Storage Corp, Piqua, plans cold-storage and refrigerating plant, with locker system of about 300 units. Cost over $80,000, with equipment. Financing is under way.

Tippecanoe City contracted Henry Stock & Son, North Ludlow St, Dayton, Ohio, for addition to municipal electric plant, for expansion in turbine room. Cost over $75,000, with equipment. Walter I Barrows, Reibold Bldg, Dayton, consulting engineer.

Board of Education, Toledo, R S Wenzlau, director of schools, plans central-heating plant in new junior high school. Fund of $378,000 has been approved. Bids will be asked soon on general erection.

OKLAHOMA——Duncan plans extensions in municipal electric plant, with installation of two new diesel-generator units and auxiliary equipment. Cost about $276,000, of which $134,000 has been secured through Federal grant. Proposed to begin work soon.

Cordell plans improvements in municipal electric plant, including new 600-hp diesel-generator unit and accessories, cooling system and auxiliary equipment. Cost about $66,200. Financing through Federal aid. V V Long & Co, Colcord Bldg, Oklahoma City, consulting engineers.

Board of Education, Ada, plans central-heating plant in new junior high school. Cost about $300,000. Financing through Federal aid. Albert Ross, American Bldg, architect.

Erick plans extensions in municipal electric plant. Cost about $104,000. Financing through Federal aid. V V Long & Co, Colcord Bldg, Oklahoma City, consulting engineers.

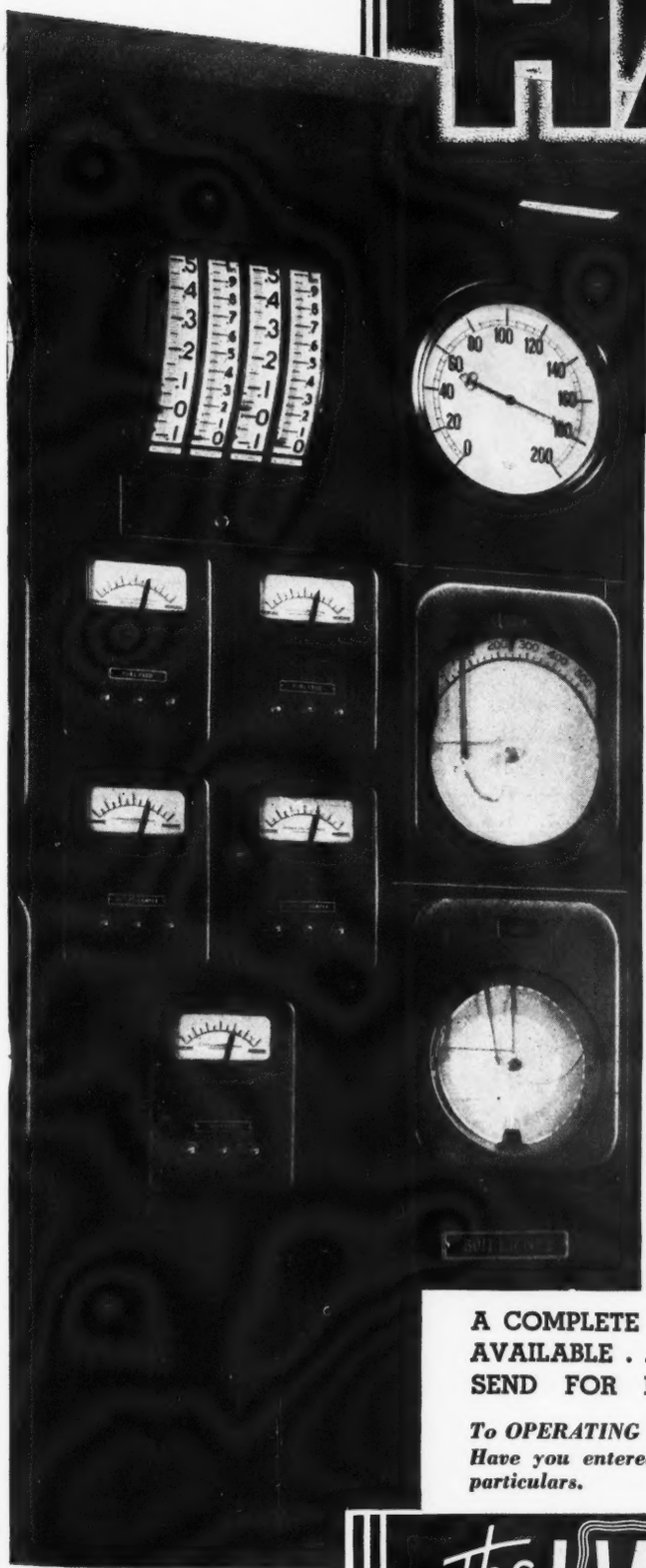
Prague plans municipal electric plant, using diesel-generator units, and improvements in electrical distributing system. Cost about $68,000, of which $31,909 has been secured through Federal grant. Holway & Neuffer, 315 East 18th St, Tulsa, consulting engineer.

PENNSYLVANIA——Atlantic Refining Co, Philadelphia, contracted Ingersoll-Rand Co, for condensers, condenser pumps and boiler-feed pumps, with accessories, for new 18,500-ton tanker to be built at yard of Sun Shipbuilding & Drydock Co, Chester.

SOUTH DAKOTA——Freeman plans municipal electric plant, using diesel-generator units and auxiliary equipment. Fund of $106,000 has been secured through Federal aid for station and distributing lines. Buell & Winter Engrg Co, Insurance Exchange Bldg, Sioux City, Iowa, consulting engineer.

Board of Trustees, University of South Dakota, Vermillion, plans power house at institution. Cost about $150,000, with equipment. Financing will be arranged through Federal aid. W W Davidson at University is engineer in charge.

TENNESSEE——Board of Wilson County Commissioners, Lebanon, plans central-heating plant for new county court house



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—benefits you in these ways:

1 Maintains steam pressure practically constant under wide variations in demand.

2 Maintains the correct fuel-air ratio for the most efficient combustion.

3 Maintains over-fire draft constant at a predetermined value.

4 Keeps fuel-burning rate in step with steam demand.

5 Protects furnace and boiler by more uniform firing conditions and by the smaller fluctuations of steam pressure and furnace temperature.

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8 Makes corrections before conditions get out of hand.

9 Lessens clinker trouble.

10 Reduces smoke and clogging of tubes to the minimum.

11 Permits load variations to be carried by the entire battery of boilers or by an individual boiler, as desired.

12 Is always on the job, never tires, never forgets.

A COMPLETE NEW BOOK ON COMBUSTION CONTROL IS NOW AVAILABLE . . . 40 PAGES OF VALUABLE INFORMATION . . . SEND FOR IT . . . IT'S FREE! . . . WRITE TO DEPT. 1-10-8.

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COMBUSTION TESTING INSTRUMENTS

The HAYS CORPORATION
COMBUSTION INSTRUMENTS SINCE 1901
MICHIGAN CITY, INDIANA, U.S.A

PUT "Live Action" ON GUARD

to keep your equipment at its most efficient degree of tightness

Diesels, Reciprocating Engines, Pumps, Conveyors, Generators, Stokers, Ash Handling Equipment, and many other types of power plant equipment that shake and jar need the sure protection of

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The Nut that can't shake loose

Live action is provided by the built-in locking ring that's always ready to spring to life whenever vibration tends to loosen the nut and grip the bolt or stud with an unfailing hold. A wrench will remove it and it can be used over and over.

Cutout section showing Locking Ring in place.

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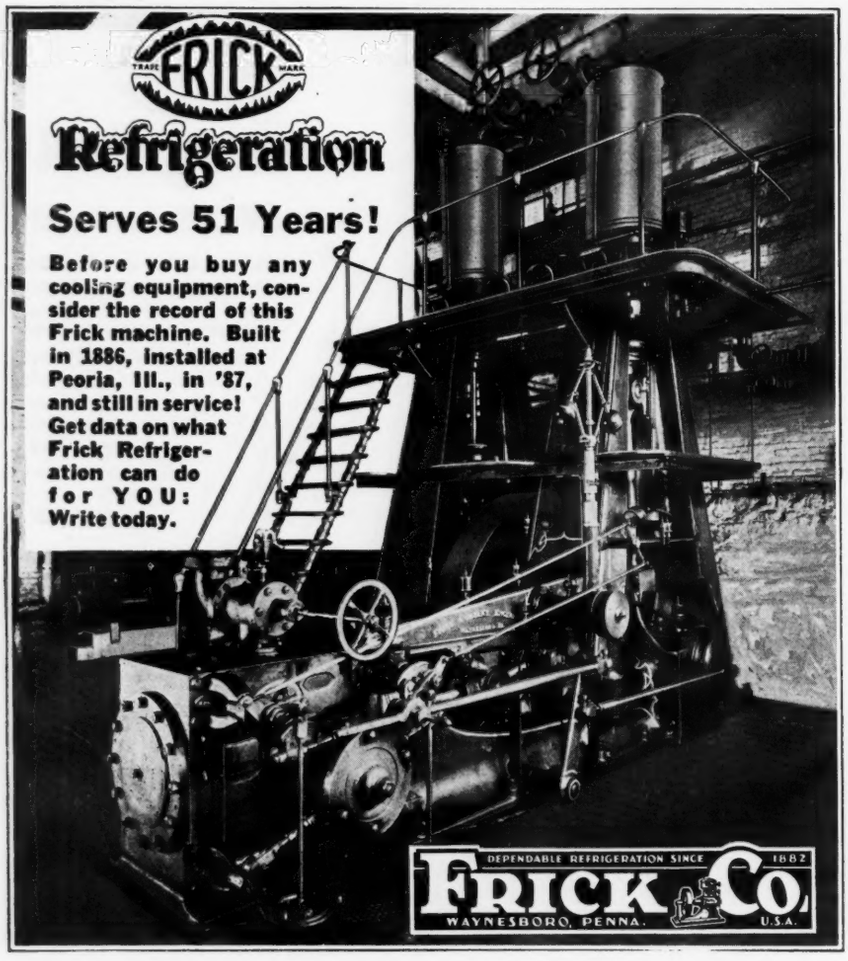
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Refrigeration
Serves 51 Years!
Before you buy any cooling equipment, consider the record of this Frick machine. Built in 1886, installed at Peoria, Ill., in '87, and still in service! Get data on what Frick Refrigeration can do for YOU: Write today.
DEPENDABLE REFRIGERATION SINCE 1882
FRICK CO.
WAYNESBORO, PENNA. U.S.A.

and jail building. Cost about $200,000. Financing is being arranged through Federal aid. Marr & Holman, Stahlman Bldg, Nashville, architects.

Board of Tipton County Commissioners, Covington, plans central-heating plant in new courthouse. Cost about $200,000. Financing has been arranged through Federal aid. Marr & Holman, Stahlman Bldg, Nashville, architects.

Jennings A Jones, Murfreesboro, heads project to construct and operate cold-storage and refrigerating plant, with locker system. Cost about $45,000.

TEXAS——Lampassas plans municipal butane-gas plant and system. Cost about $65,000. Financing being arranged through Federal aid. Joseph J Rady, Majestic Bldg, Fort Worth, consulting engineer.

Baird plans municipal electric plant, using diesel-generating units and accessories. Cost about $150,000. Financing through Federal aid.

Board of Education, El Paso, plans central-heating plant in new Bowie high school. Cost about $325,000. Financing through Federal aid. Trost & Trost, El Paso National Bank Bldg, architects.

Goose Creek has engaged Garrett Engrg Co, 308 Hughes St, Houston, consulting engineer, to make surveys and estimates of cost for municipal electric plant. Financing through Federal aid.

Robstown plans municipal diesel-electric plant and municipal electrical distribution system. Cost about $275,000. Also will install municipal gas plant and system to cost approximately $75,000. Financing is being arranged through Federal aid and bond issue. Garrett Engrg Co, Houston, consulting engineer.

Blue Star Ice & Cold Storage Co, San Antonio, plans 1-story cold storage warehouse and ice plant on Blue Star St. Cost over $60,000, with equipment. James I White, 520 Nogalitos St, San Antonio, architect.

VIRGINIA——Board of Trustees, Piedmont Sanitorium, Burkesville, plans new power house and pumping station at institution. Financing for $171,200 has been arranged for this and other buildings, including Federal grant of $77,060.

Lexington plans municipal power plant and electrical distributing system. Cost about $365,000, of which $164,000 will represent a Federal grant.

WASHINGTON——Department of Interior contracted Westinghouse Electric & Mfg. Co, for three 108,000-kva electric generators, 13,800-volt, 3-phase, 60-cycle, vertical shaft, for installation in Grand Coulee hydroelectric power plant, at $2,611,000. This will be the first three of six main generator units to be installed.

Snohomish County Dairymen's Assn, Snohomish, plans rebuilding of power house at local dairy plant, recently damaged by fire.

Union Pacific Railroad Co, Union Station, Spokane, plans ice and refrigerating plant and boiler house in connection with new local warehouse on company right-of-way, to be occupied under lease by Waybright Produce Co, Spokane. Work will begin soon. Cost about $65,000.

Bellingham plans central-heating plant in new 2-story and basement city hall building. Cost about $428,000. Financing approved through Federal aid. Leonard Bindon, Medical Bldg, Bellingham, architect.

WEST VIRGINIA——Jones Brothers, Fairmont, furriers, plan 1-story cold-storage plant on site now being selected at Greensboro, N. C. Cost over $50,000.

City Council, Wheeling, and Board of County Commissioners, plan central-heating plant in proposed new multi-story city-county building and jail. Cost over $1,000,000. Financing will be arranged through Federal aid.

WASHINGTON, D. C.——Washington Gas Light Co, contracted United Engineers & Constructors, Inc, 1401 Arch St, Philadelphia, Pa., for boiler plant at 12th and M Sts, S.E. Cost over $60,000, with boiler units and other equipment.

after 12 years of service now report . . .

"EVAPORATION HIGH"
"AMPLE STEAM"
"SMOKELESS OPERATION"

DETROIT MULTIPLE RETORT STOKERS

LAMEASURE BROS., INC. Laundry, Rugs and Dry Cleaning
ESTABLISHED 1897
TELEPHONE LAFAYETTE 2200
1440-1640 TWENTY-FIRST STREET
DETROIT, MICHIGAN

July 8, 1938

Detroit Stoker Company
Detroit, Michigan

Gentlemen:

In reply to your recent inquiry as to the results that we are obtaining with our Detroit Stokers, we are pleased to advise as follows:

The equipment consists of two Detroit Multiple Retort Stokers installed in 1926 with two 360 horsepower water tube boilers. Except for periods of boiler cleaning, the units have been in almost continual service for twelve years. At no time have they failed to deliver ample steam for our process and heating load requirements. Our summer load is 160 to 175% of rating and the winter load is from 200 to 225% of rating. We find that our evaporation is high and smokeless operation, which is essential to our business, has always been obtained.

Please feel free to refer prospective customers to us at any time.

Yours truly,
Lameasure Bros. Laundry & Dry Cleaning
Walter J. Baker
Walter J. Baker, Chief Engineer

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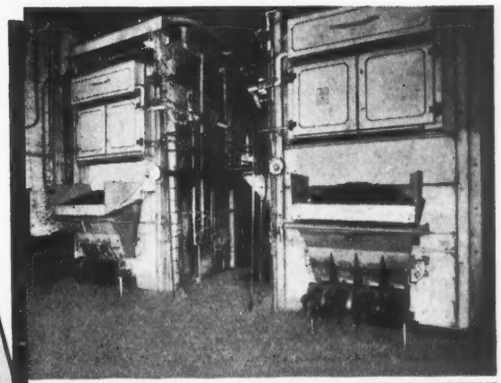

WRITE FOR BULLETIN 000

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On this diesel, LAMINUM babbitted shims (pat'd) are standard . . . for the important oil pressure control and precision adjustment of main and connecting rod bearing clearances. The same easy accuracy in service adjustments as in assembly! You simply peel off .002 in. (or .003 in.) laminations. Always a clean shim surface! Laminum sample on request.

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Subscription Rates—In United States and Canada, $3 a year. Two years, $4. (Elsewhere, $6 for one year; $9 for two years.)

Current Comment

Cost of Water Treating

WHAT WOULD BE *the cost per ton of ice to treat water containing 8 grains of calcium carbonate hardness, and what would be the approximate cost of a softener for a 50-ton plant?*

[*The foregoing was submitted by* POWER *to W J Ryan, Water Service Laboratories, New York, N. Y. His reply follows*—ED.]

FIFTY TONS of water is 12,000 gal. A plant for softening this water by precipitating most of the calcium hardness by lime, and having a capacity of 1200 gal. per hr, will cost about $1500 to $1600 installed. Treatment will require the addition of approximately 1 lb of "90%" hydrated lime per 1000 gal. and about ½ lb of commercial aluminum sulphate ("alum") per 1000 gal. This means 12 lb of lime and 4 lb of alum per day. The cost of these chemicals in small quantities varies in different localities, but figuring the lime at 1¢ per lb and the alum at 2¢ per lb, the cost for chemicals is 20¢ per day. Figuring interest, depreciation, repairs, at about $300 per year, the cost of operation would be in the neighborhood of $1.20 per day. This does not allow for attendance, but a small softening plant can probably be operated by the plant engineer or mechanic in addition to his other duties. The manufacturers of such softening plants instruct the purchaser in operation of the equipment, which is not complicated.

New York, N. Y. W J RYAN

Access Enclosures

INCREASING accessibility of piping and wiring by use of enclosures is a subject of importance to building owners and operators. No matter how well designed equipment is, and regardless of its method of installation, it will have to be repaired at some time, usually when least expected. Repairs or replacements can be facilitated and costs cut, if some means is provided for ready access to the affected equipment, usually buried in walls or floors.

If pipe or wiring must be run in walls or floors, flush enclosures at strategic points, equipped with doors, make it accessible without ripping out part of the building structure. Or piping and wiring may be run outside walls, floors, or ceilings, and covered, for appearance and protection, by a sheet-metal enclosure. Enclosures of a simple nature can be made of standard metal plates and angles.

When enclosures are used, troubles with concealed equipment disappear. No longer is it necessary to remove all sections, ceilings, or floors with destruction of paint, wallpaper, plaster, lath, tiles or brickwork. No longer is it necessary to repair damages to surroundings on top of repairing defective piping or wiring. Accessible equipment means savings

This
Reliance
EYE-HYE
Trade Mark Reg. U. S. Patent Office
Remote Reading Liquid Level Indicator

proves to be so profitable in *saving time* and *increasing safety* that repeat orders are common.

Here's proof for you that EYE-HYE brings new accuracy, new convenience to the important job of watching boiler water levels. *Scores of EYE-HYES have been shipped on repeat orders.*

EYE-HYE pulls your water level reading down out of the rafters to instrument panel or boiler room wall for quick, accurate eye-level control. Special indicating fluid shows water height in brilliant green.

Avoid dangerous accidents or operating losses from a crippled plant. This inexpensive indicator is sturdily made, like all Reliance boiler safety devices for 54 years. Safe from heat and pressure dangers, EYE-HYE gives you more accurate readings than your boiler gages.

Simple to install, regardless of obstructions. Continuous accurate operation by an undisputed scientific principle — nothing to get out of order. Hundreds in daily use.

Investigate this outstanding man-hour saving contribution to the safe, economical and efficient operation of your modern power plant. Write today for Bulletin No. 382 — worthwhile reading for any well-informed engineer.

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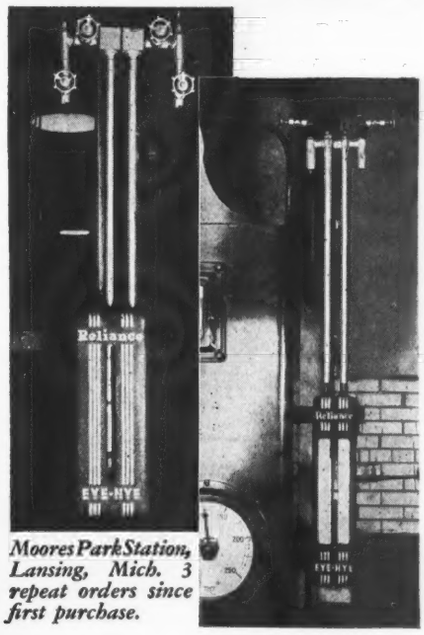
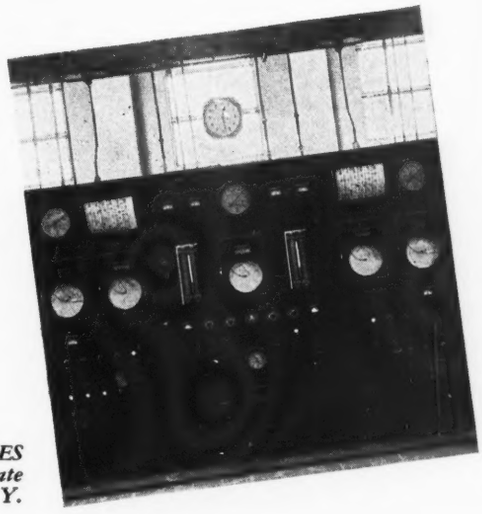


Moores Park Station, Lansing, Mich. 3 repeat orders since first purchase.

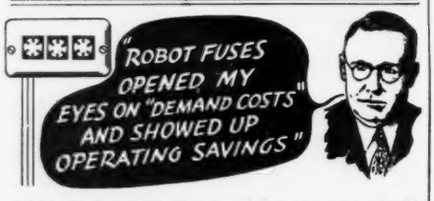


Two instrument panel EYE-HYES on 650 lb. boilers at N. Y. State Gas & Electric Co., Dresden, N. Y.

Municipal Power Plant, City of St. Louis. Repeat order for 2 more EYE-HYES after first purchase of two.

The Reliance Gauge Column Company, 5902 Carnegie Ave., Cleveland, Ohio

Reduce Electric Power Bills By Hundreds of Dollars With Robots



YOU *1: Save on Kilowatt Hour Dollars—*
NOW *2: Reduce Power-Factor "Penalties"—*
CAN *3: Cash-in-on-Higher Efficiencies—*

PROOF?—TEST THEM—before you buy them; Compare month to month K.W. Demands—or Power-Factor "penalty" REDUCTIONS. Compare too, the pyramiding operating costs of yesterday, with ROBOT Speed-Up System of TODAY.

In the above operating-graph, the heavy-line is the WARNING-LINE to reduce "unaware" gyrations, overlapping duplications, and Periodic "Penalties" contributing to HIGH DEMAND COSTS. Hence observing the automatic Signals, keeps you AWARE, keeps Maximum-Demands Uniform, and SPEEDS-UP Men-and-Machine-Hour Operations. NOTE:—ROBOTS-I-G-N-A-L-S energize work schedules to an AUTOMATON SYSTEM. WISE-EXECUTIVES CASH-IN-ON-ALL-BENEFITS — N-O-W! ON DEMAND, PLUS - - -

ROBOT FUSE INSTALLATIONS:—Plug-in at M-A-I-N-S, or Switchboard, and Wire to Signals, at plant or office. (Use Pilots, Buzzers, or Gongs.) ROBOTS are ready instantly to Signal a "PRE-SET" DEMAND adjusted to your needs. Can be re-set seasonably, or as desired.

SPECIAL 3 MONTH RENTAL OFFER:—Rent any quantity for three months use in your own plant. TEST THEM. LET THEM SHOW YOU ECONOMIES. After 90 days, you may either deduct rental-charge from purchase-price, or return them to us if not satisfactory. THE CLAIMS WE MAKE ARE SO STRONG, SO SWEEPING, WE ARE PREPARED TO LET YOU JUDGE FOR YOURSELVES IN YOUR PLANTS FOR THREE COMPLETE MONTHS.

Rental-Cost (per fuse)		Purchase-Price (list)
100 Amp. 3 mos. $3.00	Deduct From	100 Amp... $7.50 each
200 Amp. 3 mos. 6.00		200 Amp... 12.50 each
400 Amp. 3 mos. 10.50		400 Amp... 16.50 each

Above 250 Volt: For other voltages and sizes, please specify.

CHAMPION ELEC. FUSE CO. ..... 19.....
684 BROADWAY, NEW YORK Rental $.....
Gentlemen: (encl.)

Please ship on 3 month rental.....(quan.)
.....Amp. 250 Volt ROBOT SIGNAL FUSES. It is understood we may deduct above rental from Net Purchase-Price, remitting you the difference, or return fuses to you after 90 days, without further obligations to us. OUR AVERAGE ELECTRIC DEMAND IS .....K.W.

NAME .....
FIRM .....
ADDRESS .....

in material and labor costs when maintenance is necessary, savings that pay for any increase in installation cost occasioned by installing enclosures and access doors.

Yonkers, N. Y. WALTER THOMAS

Engineers' Books

Transformers

TRANSFORMER ENGINEERING (1938). *By L F Blume, G Camilli, A Boyajian and V M Montsinger, all of transformer engineering department, General Electric Co. Published by John Wiley & Sons, Inc, 440 4th Ave, New York, N. Y. 496 pages, 6x9 in., illustrated, tables, cloth binding. Price, $5.00.*

No piece of equipment has contributed more to alternating-current power systems than the static transformer. It serves as an economical and efficient means of obtaining voltage best suited to the needs of each individual power application and at the same time connects all into one system. This book is planned to facilitate the solution of the many technical problems which confront engineers in the specification, selection, application and operation of transformers. Since the book deals with technical problems incidental to transformer operation, design is discussed only as it is useful in solving operating problems.

Subject matter is treated under such headings as general nature of transformer problems, exciting currents and their effects, impedance characteristics, short-circuits, connections, thermal characteristics, voltage control and equipment, phase-angle control, insulating materials, voltage stresses, transient-voltage characteristics and insulation coordination. Even though the book represents the efforts of four engineers it is a coordinated whole, being edited by one author to produce this result.

Welding

WELDING HANDBOOK (1st Edition—1938.) *Published by the American Welding Society, 33 West 39th St, New York N. Y. 1200 pages, 6x9 in., illustrations and tables. Price $6.00.*

More than a year and a half of preparation, 90 authors and 250 reviewers guarantee authoritative and complete chapters on every phase of welding kept up to date until time of printing. Compiled by the Handbook Editorial Committee under chairmanship of Dr D S Jacobus.

Covers fundamentals of ac and dc arc welding, gas, atomic hydrogen, resistance, spot and thermit welding. Discusses soldering, brazing, hard facing and metal spraying. Additional chapters deal with materials and metallurgy, testing and inspection. Applications, safe practices, jigs and fixtures, piping, boilers, tanks and structures are approached from the standpoint of the special problems of each. A critical digest of welding literature brings in one concise section the best of scattered published material.

The Handbook combines theory with practice, giving the essentials of each in practical language understandable by anyone from metallurgist to operator.

Dams and Control Works

DAMS AND CONTROL WORKS (2nd Edition —1938). *By John C Page, Commissioner, U. S. Bureau of Reclamation. Published by U. S. Government Printing Office, Washington, D. C. 261 pages, 9x11 in., illustrated, paper cover. Price $1.00.*

Since its organization in 1902, the U. S. Bureau of Reclamation has designed and built 138 dams and is now engaged in directing the largest construction program in its history. Outstanding in the work of the Bureau are Boulder dam on the Colorado River, completed in 1936, and Grand-Coulee dam now under construction on the Columbia River. Four times in its history the Bureau has established records for building the highest dams in the world, including 726.4-ft. Boulder dam.

Work of the Bureau takes in many interesting engineering and technical features, but this book is confined to a semi-technical discussion of dams and control works including Boulder, Grand-Coulee and 19 others. It also contains 10 articles on special subjects pertaining to dam construction.

Lubrication

GENERAL DISCUSSION ON LUBRICATION & LUBRICANTS (Proceedings of the Institution of Mechanical Engineers, October 13-15, 1937). *Published in the United States by The American Society of Mechanical Engineers, 29 West 39th St., New York, N. Y. 1155 pages, 5½x 8½ in., 460 illustrations, 135 tables, buckram binding. Price $6.50*

Organized by the Institution of Mechanical Engineers with the cooperation of 53 engineering and scientific bodies in all parts of the world a general discussion on lubrication and lubricants was held in Westminster, England, October 13 to 15, 1937. Object of this discusion was to review present science and practice of lubrication in order to correlate theory and pure research with practice, to consider methods of bearing design, to obtain current views upon bearing metals, and to bring out the significance of laboratory tests, including wear and friction tests.

This book is a compilation of the 136 papers presented and the discusion on them by 163 leading authorities. These are arranged in four groups; 46 papers on journal and thrust bearings; 33 on engine lubrication; 25 on industrial applications; and 32 on properties and testing. Obviously it is practically impossible to give a general idea of what is in all these papers, because of the tremendous scope they cover.